Mission Directorate:	Science
Theme:	Planetary Science

Theme Overview

Planetary Science ascertains the content, origin, and evolution of the solar system and the potential for life elsewhere. The scientific imperative for Planetary Science, the quest to understand our origins, is universal. How did we get here? Are we alone? What does the future hold? These overarching questions lead to more focused, fundamental science questions about our solar system: How did the Sun's family of planets, satellites, and minor bodies originate and evolve? What are the characteristics of the solar system that lead to habitable environments? How and where could life begin and evolve in the solar system? What are the characteristics of small bodies and planetary environments and what potential hazards or resources do they hold?

To address these science questions, NASA relies on various flight missions, research and analysis, and technology development. Seven Planetary Science programs support an integrated and mission-balanced strategy.

- The Research Program supports planetary Research & Analysis (R&A) including sample curation; data archiving; dissemination and analysis; Near-Earth Object Observation; and Rosetta, instruments operating on the European Space Agency (ESA) comet-bound spacecraft.
- The Lunar Quest Program includes an operating mission, Lunar Reconnaissance Orbiter (LRO); one mission in development, the Lunar Atmosphere and Dust Environment Explorer (LADEE); and potential future small spacecraft missions, the Lunar Science Institute, and lunar-related R&A.
- The Discovery Program has two spacecraft in prime mission operations, MErcury Surface, Space ENvironment, GEochemistry, and Ranging (MESSENGER) and Dawn; an instrument operating on an ESA Mars Express mission, the Analyzer of Space Plasma and Energetic Atoms (ASPERA-3); a mission in development through September 2011, the Gravity Recovery And Interior Laboratory (GRAIL); one mission of opportunity, Strofio; one investigation using re-purposed spacecraft, New Exploration of Comet Tempel 1 (NExT), hosted on the Stardust; and Discovery 12, currently in the evaluation and selection process.
- The New Frontiers Program includes: one currently operating spacecraft, New Horizons; Juno, which will begin its operations phase in September 2011; and the soon-to-be-selected New Frontiers 3 mission.
- The Mars Exploration Program comprises two orbiting spacecraft, Odyssey and Mars Reconnaissance Orbiter (MRO), and two rovers, Spirit and Opportunity, all in operation; two missions in development phase, Mars Science Laboratory (MSL) and Mars Atmosphere and Volatile EvolutioN (MAVEN); and R&A and program management. Additionally, the NASA/ESA 2016 ExoMars Trace Gas Orbiter (EMTGO) is in pre-formulation phase.
- The Outer Planets Program includes research, one operating mission, Cassini, and an Outer Planets flagship mission study and formulation.
- The Technology Program includes In-Space Propulsion (ISP) systems, advanced power generation, NASA-Department of Energy (DOE) cost sharing of Plutonium Restart, and the Advanced Multi-Mission Operations System (AMMOS).

Planetary Science data furthers NASA's exploration agenda. Science data from many Planetary missions provides critical information for future human missions. Robotic Mars orbiters are mapping resources (e.g., water and minerals) on or near Mars' surface. In its hunt for asteroids that are potential impact hazards to Earth, the NEO Observations program will find and characterize a subset of these NEOs, those that present the best targets for human exploration. NASA's human Exploration Program has occasionally provided experiments to be flown on robotic planetary spacecraft. Such experiments address requirements unique to human exploration, such as measuring the radiation environment at Mars. Planetary Science continues to work closely with the Human Exploration Program to enhance and enable future human expansion into the solar system.

Mission Directorate:	Science
Theme:	Planetary Science

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**1,364.4**	**-**	**1,488.9**	**1,365.7**	**1,326.4**	**1,271.0**	**1,188.9**
Planetary Science Research	161.6	-	183.9	196.0	208.6	208.4	210.5
Lunar Quest Program	94.5	-	114.5	81.2	48.9	28.1	19.5
Discovery	184.5	-	175.6	205.1	245.7	265.5	242.8
New Frontiers	279.6	-	176.9	265.8	245.5	291.1	296.3
Mars Exploration	438.2	-	594.4	433.1	408.7	309.0	245.9
Outer Planets	100.6	-	120.8	80.5	82.2	84.1	88.5
Technology	105.5	-	122.9	104.1	86.6	84.9	85.4

Note: The new Planetary Science decadal survey, developed by the National Academies, will be released in March 2011. The decadal survey is designed to broadly canvas the field of planetary science to determine the current state of knowledge and then identify and prioritize the most important scientific questions and associated missions during the 2013-2022. NASA will re-examine all elements of the Planetary Science program and may modify future budget and content to better align with the findings and recommendations of the report.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the program amounts shown above. The allocation to each program is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Plans for FY 2012

Planetary Science Research

The Research and Analysis (R&A) program will continue to release research announcements and make research project and grant selections. The Planetary Data System will continue to archive and release planetary science data to the science community in a timely manner, enabling further scientific analysis. The Astromaterial Curation project will continue its efforts on curation and distribution of solar system samples returned by NASA planetary missions such as Stardust and Genesis. The Rosetta project will continue toward its arrival at comet Churyumov-Gerasimenko (January 2014). The expanded Near-Earth Orbit Observation (NEOO) program will improve and increase its efforts to detect Earth approaching asteroids and comets that may provide resources for our exploration of the inner solar system, or could become potential impact hazards to the Earth. It will also expand efforts to characterize their nature, both to better understand their composition and provide information for study of potential hazard mitigation techniques.

Lunar Quest Program

LADEE was confirmed to proceed into implementation (Phase C) in August 2010. It is scheduled to complete its Critical Design Review (CDR) in fiscal year (FY) 2011, and will start assembly, test, and launch operations in FY 2012. LRO has been successfully transitioned from the Exploration Systems Mission Directorate, and it will continue to perform science and measurements throughout FY 2012. The Surface Science Lander Technology project will continue its risk reduction efforts during FY 2012. Research announcements for Lunar Research and Analysis will be released annually, to be followed by selections and awards.

Discovery

MESSENGER Mercury orbit insertion is scheduled for March 2011, and will make measurements and perform data analyses throughout FY 2012. The Dawn spacecraft is scheduled for Vesta orbit insertion in July 2011, where it will spend a year at Vesta, performing data collection and analysis. It will then continue onto Ceres. ASPERA-3, an instrument on the ESA Mars Express spacecraft, will continue to collect data throughout FY 2012. Stardust NexT will encounter Tempel 1 in February 2011 and enable comparative analysis of the recent findings to those of the 2005 Deep Impact mission. GRAIL is currently scheduled to launch in September 2011. The spacecraft will perform lunar orbit insertion in January 2012, to be followed by science measurement and data analysis. Strofio, an instrument selected to fly on ESA's BepiColombo spacecraft is scheduled to launch in 2014, and will complete CDR by the end of FY 2012. NASA plans to make concept study selections in late FY 2011, to be followed by a down-selection to one mission in FY 2012.

New Frontiers

Juno is currently scheduled to launch in August 2011. The spacecraft will spend five years cruising and performing periodic deep space maneuver as it makes its way to Jupiter. The New Horizons mission will continue on its course toward Pluto and its moons, with periodic spacecraft and instrument checkouts as it cruises. New Frontiers 3 mission is scheduled to be down-selected in late CY 2011, and will proceed into Phase B in FY 2012.

Plans for FY 2012

Mars Exploration

MSL is currently scheduled to launch in November 2011. The rover, named Curiosity, will land on the surface of Mars in August 2012 and will start surface operations and measurements. MAVEN was confirmed to proceed into implementation phase in October 2010. It will complete CDR by the end of FY 2011, and will enter into ATLO phase by the end of FY 2012. Odyssey has been successfully moved to its new orbit and will continue to detect minerals on the surface of Mars while conducting relay operations for the Spirit and Opportunity Mars rovers. MRO will continue with hi-resolution imaging and, if technically possible, both Spirit and Opportunity rovers, will continue to explore and perform data analysis throughout FY 2012. Having successfully finalized the negotiation with ESA on the 2016 ExoMars Trace Gas Orbiter (EMTGO), the project will complete PDR by the end of FY 2011, to be followed by a CDR by the end of FY 2012, and ESA has already passed their system-level PDR in December 2010.

Outer Planets

NASA Cassini project completed its Equinox mission in July 2010, and started the Solstice mission in August 2010. The Cassini project will operate through Saturn's northern summer solstice and will perform data analysis through March 31, 2018. The Agency will continue to negotiate the details of potential partnerships with ESA and other international partners for future outer planet missions.

Technology

The ISP will continue toward completion of the NASA's Evolutionary Xenon Thruster (NEXT) electric propulsion life validation, and will initiate technology study and feasibility on the Mars Ascend Vehicle (MAV). The Radioisotope Power Systems (RPS) program, working with the DOE, will start the flight development of the Advanced Stirling Radioisotope Generator (ARSG) that would support a flight in 2016 or 2017. The AMMOS project will continue to provide and develop multi-mission software tools for spacecraft navigation and mission planning throughout FY 2012. NASA will continue work, in partnership with the Department of Energy, to re-establish a domestic capability to produce plutonium-238 for use in radioisotope power systems.

Relevance

Relevance to national priorities, relevant fields, and customer needs:

The Planetary Science program is guided by the 1958 National Aeronautics Space Act, subsequent legislation, U.S. National Space Policy, and related policies that call on NASA to conduct robotic missions throughout the solar system. The program follows NASA's tradition of establishing its science priorities through consultation with world-class experts via the National Academies' decadal survey process. The most recent planetary science decadal survey was published in 2002, and the next one is scheduled for release in March 2011. Planetary Science also receives tactical-level advice from the external science community via the Planetary Science Subcommittee of the NASA Advisory Council.

Planetary Science seeks to achieve both near and long-term science goals by studying solar system objects and phenomena primarily in situ, but also by returning samples for study in laboratories on Earth. Planets and satellites of the solar system and the ancient icy bodies far from the Sun are effectively "Rosetta stones," or objects that facilitate interpretation. The Rosetta stones of interest to NASA can tell unique stories about the origin and evolution of the solar system. As researchers learn more about the origins of living organisms on Earth and about the solar system's planets and moons, they may learn if life has arisen in places beyond Earth.

Robotic explorers gather data to help scientists understand the nature and evolution of asteroids, comets and other small bodies in the solar system, how the planets formed, what triggered different evolutionary paths among planets, and how Earth formed, evolved, and became habitable. To search for evidence of life beyond Earth, scientists use these data to map zones of habitability, study the chemistry of alien worlds, and unveil the processes that lead to conditions necessary for life. Robotic exploration will generate knowledge about the elements of our solar system--information needed to identify the most promising human exploration missions. This knowledge will help enable safer human space exploration in the forbidding environments they will encounter and may aid in the mitigation of hazards to life here on Earth.

Relevance to the NASA Mission and Strategic Goals:

Planetary Science programs support NASA's achievement of Strategic Plan 2, to "Expand scientific understanding of the Earth and the universe in which we live."

Emphasis is on the Agency objective, to "Ascertain the content, origin, and evolution of the solar system and the potential for life elsewhere."

Relevance to education and public benefits:

Planetary Science uses its missions, research programs, and the human resources of the space science community to enhance the quality of American science, technology, engineering, and mathematics (STEM) education. As an example, many of our missions are using mission data to create authentic education experiences and engage students from secondary school through graduate school. Additionally, the Robotics Alliance project (RAP) provides students the opportunity to engage with government, industry and university experts for hands-on, realistic exposure to engineering and technical professions, and it serves as a concrete example of the Planetary Science program's contribution to education. NASA's Planetary Science theme is dedicated to sharing the excitement of discoveries and knowledge generated by space science missions and research with the public, thus contributing to educating and inspiring the next generation of STEM employees needed for the 21st century.

The innovative nature of planetary science projects also creates an impetus for new techniques and technologies that later benefit the public. Public benefits from Planetary Science include a growing understanding of the solar system and Earth's significance within it. Comparative planetology leads to an understanding of Earth's past geologic history and potential future environment; for example, Venus has undergone a runaway greenhouse effect, and Mars, which was once much warmer and wetter, is now cold and dry.

NASA's robotic science missions are paving the way for understanding the origin and evolution of the solar system and working to identify past and present habitable locations.

Mission Directorate:	Science
Theme:	Planetary Science

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Strategic Goal 2	**Expand scientific understanding of the Earth and the universe in which we live.**	
Outcome 2.3	**Ascertain the content, origin, and evolution of the solar system and the potential for life elsewhere.**	
Objective 2.3.1	**Inventory solar system objects and identify the processes active in and among them.**	
Performance Goal 2.3.1.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***	
APG 2.3.1.1: PS-12-1	Demonstrate planned progress in inventorying solar system objects and identifying the processes active in and among them. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs
Performance Goal 2.3.1.2	***By 2015, launch at least two missions in support of this outcome.***	
APG 2.3.1.2: PS-12-2	Complete the mission concept studies for the New Frontiers 3 mission.	New Frontiers
APG 2.3.1.2: PS-12-3	Complete the Discovery 12 mission concept studies.	Discovery
Objective 2.3.2	**Improve understanding of how the Sun's family of planets, satellites, and minor bodies originated and evolved.**	
Performance Goal 2.3.2.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***	
APG 2.3.2.1: PS-12-4	Demonstrate planned progress in understanding how the Sun's family of planets, satellites, and minor bodies originated and evolved. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs
APG 2.3.2.1: PS-12-5	Complete MESSENGER mission success criteria.	Discovery
Performance Goal 2.3.2.2	***By 2015, launch at least three missions in support of this outcome.***	
APG 2.3.2.2: PS-12-2	Complete the mission concept studies for the New Frontiers 3 mission.	New Frontiers
APG 2.3.2.2: PS-12-6	Complete the Lunar Atmosphere and Dust Environment Explorer (LADEE) Systems Integration Review.	Lunar Quest Program
Objective 2.3.3	**Improve understanding of the processes that determine the history and future of habitability of environments on Mars and other solar system bodies.**	
Performance Goal 2.3.3.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***	
APG 2.3.3.1 : PS-12-7	Demonstrate planned progress in understanding the processes that determine the history and future of habitability of environments on Mars and other solar system bodies. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs

Mission Directorate:	Science
Theme:	Planetary Science

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Performance Goal 2.3.3.2	***By 2015, launch at least two missions in support of this outcome.***	
APG 2.3.3.2: PS-12-10	Complete the Mars 16 Mission Confirmation Review.	Mars Exploration
APG 2.3.3.2: PS-12-8	Complete the Mars Science Laboratory (MSL) Launch Readiness Review.	Mars Exploration
APG 2.3.3.2: PS-12-9	Complete the Mars Atmosphere and Volatile EvolutioN Mission (MAVEN) Systems Integration Review.	Mars Exploration
Objective 2.3.4	**Improve understanding of the origin and evolution of Earth's life and biosphere to determine if there is or ever has been life elsewhere in the universe.**	
Performance Goal 2.3.4.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***	
APG 2.3.4.1 : PS-12-11	Demonstrate planned progress in understanding the origin and evolution of life on Earth and throughout the biosphere to determine if there is or ever has been life elsewhere in the universe. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs
Objective 2.3.5	**Identify and characterize small bodies and the properties of planetary environments that pose a threat to terrestrial life or exploration or provide potentially exploitable resources.**	
Performance Goal 2.3.5.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***	
APG 2.3.5.1: PS-12-12	Demonstrate planned progress in identifying and characterizing small bodies and the properties of planetary environments that pose a threat to terrestrial life or exploration or provide potentially exploitable resources. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs
Performance Goal 2.3.5.2	***Return data for selection of destinations in order to lower risk for human space exploration beyond low Earth orbit.***	
APG 2.3.5.2: PS-12-13	Demonstrate planned progress in characterizing potentially hazardous objects that are possible destinations for future human space exploration.	Multiple Programs

Mission Directorate:	Science
Theme:	Planetary Science

Uniform and Efficiency Measures:

Measure #	Description
Planetary Science Theme	
APG EFF: PS-12-14	Complete all development projects within 110 percent of the cost and schedule baseline.
APG EFF: PS-12-15	Deliver at least 90 percent of scheduled operating hours for all operations and research facilities.
APG EFF: PS-12-16	Peer-review and competitively award at least 95 percent, by budget, of research projects.
APG EFF: PS-12-17	Reduce time within which 80 percent of NASA Research Announcement (NRA) grants are awarded, from proposal due date to selection, by four percent per year, with a goal of 180 days.

Performance Achievement Highlights:

Data from NASA's two Mars rovers, along with orbiters Mars Odyssey, MRO, and the ESA/NASA Mars Express (all of which have continued to operate beyond their prime mission) show that the planet had a relatively wet environment. Evidence indicates that the climate evolved, with the planet passing through a major transition during which water on or near its surface became ephemeral and acidic. Early Mars produced diverse mineralogy deposits, such as clays, that may be evidence for ancient lakes, springs, or groundwater. MRO and the rover Spirit found carbonate deposits, which would have been destroyed by acidic conditions if acidity were globally prevalent. Another revelation, from radar and high-resolution imagery, has been the discovery of near subsurface ice at the mid-latitudes. This is evidence of episodic large-scale changes in the Martian climate. The purported variability in methane indicates that the planet is still very active, and may provide an environment for possible microbial life on Mars, even today.

The concept of the Moon as a very dry destination shifted in 2010 with the confirmation of the presence of water by the M3 instrument aboard the Indian Space Research Organisation (ISRO) Chandrayaan-1 spacecraft. Its data show hydroxyl and water molecules are present on the surface of the Moon in the polar regions at very small, but surprisingly high levels (based on current Lunar origin theories). Other observations, from LRO and M3 showed the entire lunar surface to be hydrated during some portions of the day.

Near-Earth asteroids are often portrayed as impact hazards, massive rocks that destroy plant and animal life. However, life on Earth has persisted, despite asteroid bombardments throughout its history. Leading theories derived from NASA research show that asteroids and comets may have provided early Earth with the essential elements needed for the Earth to become a living planet. Recent findings of water ice on comets and some asteroids suggests that a period of asteroid bombardment delivered much of the water and other building blocks for life.

New research on Europa and its oceans shows that tidal forces appear to push fresh ice upward from below in a cycle that forms double ridges on at least half of Europa's surface. As ridges pile on top of ridges, older oxygenated material gets buried, shoving oxygen-rich matter downward toward the liquid water. Scientists have estimated that after one or two billion years, this process could deliver enough oxygen-rich material to Europa's ocean to reach the same concentration levels as those of Earth's oceans. This oxygen could provide the necessary environment to nurture life.

Cassini observations improve our understanding of Enceladus and Titan. Icy material is ejected from the vents of a near-surface of Enceladus, like cold versions of the Old Faithful geyser in Yellowstone National Park. Scientists discovered evidence of sodium salts in the ice grains comprising the plumes, representing evidence that there are liquid subsurface lakes or an ocean on tiny Enceladus. Cassini observations of Titan have found a major methane "hydrological" cycle in operation. Methane rain is currently falling from the southern hemisphere of Titan, contributing to the increase in size of the southern methane lakes. This cycle, along the discovery of ice volcanoes, shows that Titan is larger than the planet Mercury, may be an excellent "early-Earth" analog.

Research in NASA's Astrobiology program may have found an alternative biochemistry of life, and opened up a new approach for life detection experiments on NASA's planetary missions. Microbes in California's Mono Lake were found to substitute arsenic for phosphorous in their DNA. Arsenic, which is chemically similar to phosphorus, is poisonous for most life on Earth. The implication is phosphorus may not be as essential for life as previously thought.

Mission Directorate:	Science
Theme:	Planetary Science

Independent Reviews:

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	NASA Advisory Council	07/2010	Reviews science and program implementation strategies and relevancies to the NASA strategies and goals. Findings from review included: NASA has made significant progress toward implementing the recommendations of the NRC's decadal survey and Mars architecture report; and that NASA's current planetary exploration program is highly productive, carrying out exciting missions and making fundamental discoveries.	2/2011
Relevance	National Academies	12/2003	Published priorities in a decadal report entitled "New Frontiers and the Solar System: An Integrated Exploration Strategy." The current decadal survey began in 2009 and it is to be completed by March 2011.	03/2011

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Planetary Science Research

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**161.6**	**-**	**183.9**	**196.0**	**208.6**	**208.4**	**210.5**
Planetary Science Research and Analysis	131.5	-	134.6	135.3	140.0	142.8	149.8
Other Missions and Data Analysis	21.3	-	23.7	25.5	31.7	28.2	23.0
Education and Directorate Management	3.0	-	5.1	14.7	16.3	16.7	16.5
Near Earth Object Observations	5.8	-	20.4	20.5	20.6	20.7	21.1

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In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Program Overview

The Planetary Science Research Program is where the data retrieved from missions is combined with observations in ground-based laboratories to improve our understanding of the content, origin, and evolution of Earth's solar system and planetary systems in general. It does this by supporting the development of theoretical tools and laboratory data needed to analyze flight data, inventing new and better instruments to fly on future missions, and providing analysis of the data returned.The program represents an essential complement to flight missions, providing the scientific research and the theoretical foundation to allow the Nation to plan and fully utilize the unique data sets returned from the missions exploring the solar system. It is also NASA's primary interface with university faculty and graduate students in this field as well as the research community in general. The research program achieves this goal by supporting research grants solicited annually and subjected to a careful peer review before award.

For further information see: http://nasascience.nasa.gov/planetary-science.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Planetary Science Research

Plans For FY 2012

In pursuit of fundamental science that guides planetary exploration, competitive announcements will again be released soliciting R&A proposals for selection. Planetary Science will continue data archiving and distribution of this vital data to the science community in a timely manner for further scientific analysis. Likewise, curation and distribution of solar system samples (astromaterials) returned by NASA planetary missions such as Stardust, Genesis, and Apollo will continue.

Support will also continue for the Rosetta mission toward its arrival at comet Churyumov-Gerasimenko (January 2014). The remaining data from the Hayabusa mission will be archived by the Planetary Data System, and curation of returned samples will be started in FY 2011. NASA will continue to expand Near Earth Object Observation (NEOO) efforts at finding and characterizing asteroids and comets approaching Earth that may be destinations and resources for our exploration of the solar system, or could become potential impact hazards to Earth.

Project Descriptions and Explanation of Changes

Planetary Science Research and Analysis (R&A)

The scope of R&A is very broad, as the project provides the foundation for the formulation of new scientific questions and strategies, as well as maximizing the return on the investments the nation has already made in robotically exploring the solar system. R&A must provide new theories and instrumentation that enable the next generation of flight missions. Discoveries and concepts developed in the R&A project are the genesis of scientific priorities, missions, instrumentation, and investigations. R&A supports research tasks in areas such as: astrobiology and cosmochemistry; the origins and evolution of planetary systems; and the atmospheres, geology, and chemistry of the solar system's planets, other than Earth. R&A provides for instrument and measurement concepts, and supports the initial definition of mission concepts and development of instruments for future Discovery, New Frontiers, Mars, or outer planets missions.

Other Missions and Data Analysis

Rosetta, an comet rendezvous mission launched in March 2004 through a partnership between ESA and NASA, will arrive at comet Churyumov-Gerasimenko in FY 2014. Rosetta will enable study of the nature and origin of comets, the relationship between cometary and interstellar material, and the implications of comets with regard to the origin of the solar system. The Rosetta spacecraft will be the first to undertake the long-term exploration of a comet at close quarters. It comprises a large orbiter, which is designed to operate for a decade at large distances from the Sun, and a small lander. Each of these elements carries a large complement of scientific experiments and examinations designed to complete the most detailed study of a comet ever attempted. Rosetta will allow scientists to look back 4,600 million years to a time when no planets existed and only a vast swarm of asteroids and comets surrounded the Sun.

With its successful return to Earth in 2010, the Hayabusa (MUSES-C), a mission primarily operated by the Japanese space agency, JAXA, has completed its mission. The spacecraft launched in May of 2003 and landed on the asteroid Itokawa in November 2005. Hayabusa observed Itokawa's shape, geographical features, reflectance, mineral composite, and gravity from an altitude of 3 to 20 km, and clarified Itokawa's structure as a "pile of rubble." In April 2007, the spacecraft began its return to Earth with an asteroid sample and successfully landed in the Australian Outback on June 14, 2010. The sample is now in curation and analysis to reveal the composition of the near-Earth asteroid, Itokawa.

The Planetary Data Systems (PDS) and Astromaterials Curation projects support data archives; sample processing and storage facilities; and analysis tools needed to perform research. PDS is the active data archive for NASA's Planetary Science theme. The Astromaterials Curation Facility at Johnson Space Center provides services for all returned planetary materials that do not require planetary protection laboratories.

Education and Directorate Management

The Directorate Management project supports SMD-wide administrative and programmatic requirements.

The Robotics Alliance Project (RAP) is dedicated to increasing interest in STEM disciplines among youth in the United States. Annual activities and events expose students to challenging applications of engineering and science. RAP supports national robotic competitions in which high school students team with engineers from government, industry, and universities to gain hands-on experience and mentoring from engineering and technical professionals.

Near Earth Object Observations (NEOO)

The NEOO project detects and tracks at least 90 percent of the near Earth objects (NEOs)--asteroids, and comets that come within 1.3 astronomical units of the Sun. It's long term goal is to find those of at least 140 meters in size that have any potential to collide with Earth and do significant damage to the planet. In the course of this effort, initial characterization of NEOs that could be viable targets for robotic and crewed exploration will also occur. In accordance with the findings and recommendations of the January 2010 NRC study on the NEO hazard, NEOO will continue to:

- Collect, archive, and analyze the small body data collected by NASA's WISE mission, and support increased follow-up and analysis of this data;

- Enable collection of NEO detection and characterization data by ground-based systems, including the U.S. Air Force's (USAF) Panoramic Survey Telescope and Rapid Reporting System (Pan-STARRS) and investigate the use of other USAF space surveillance assets for this mission;

- Support the continued operation of planetary radar capabilities at the NSF's Arecibo and NASA's Goldstone facilities; and

- Investigate both ground and space-based concepts for increasing capacity to detect, track and characterize potentially hazardous objects down to sizes 140 meters and below.

More information on NASA's NEO program is available at http://neo.jpl.nasa.gov/.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Planetary Science Research

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Release of research announcements soliciting R&A proposals (annual selections)	Research and Analysis (R&A)	Same
Meeting commitments to the international partners as agreed to in formal agreements	Hayabusa	Missions completed
Meeting commitments to the international partners as agreed to in formal agreements	Rosetta	Same
Archive and release mission data to the science community within six months of downlink	Planetary Data System (PDS)	Same
Store new samples of astromaterials and distribute them as requests are approved by CAPTEM	Astromaterials Curations	Same
Improve the search for hazardous NEOs, asteroids, and comets down to 140 meters in size that may pose an impact threat. Add elements for upgrading search and characterization of NEOs on NASA, NSF and USAF assets.	NEOO	Same

Implementation Schedule

Project	Schedule by Fiscal Year																Phase Dates		
	Prior	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24		Beg	End
R&A, PDS, Curation																	Tech Form Dev Ops Res	 Oct-68	 Sep-24
Rosetta																	Tech Form Dev Ops Res	 Mar-04 Sep-08	 Mar-04 Sep-17 Sep-17
NEOO																	Tech Form Dev Ops Res	 Oct-07	 Sep-24

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Program Management

NASA HQs is responsible for R&A. JPL is responsible for the operations of the NASA instruments in the ESA Rosetta spacecraft and the NEOO Program Office. GSFC is responsible for PDS project management. JSC is responsible for Astromaterial Curation.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Research & Analysis	HQ	Multiple (NASA Centers, Universities, industries, etc.)	n/a
Rosetta	JPL	JPL	The European Space Agency (ESA) built the spacecraft, provided the launch vehicle, and operates the spacecraft.
Planetary Data System (PDS)	GSFC	JPL and ARC	n/a
Astromaterials Curation	JSC	JSC and DFRC	NSF and Smithsonian Institution for Antarctic meteorites.
NEOO	HQ	JPL and GSFC	n/a

Acquisition Strategy

The R&A budget will fund competitively selected activities from the Research Opportunities in Space and Earth Science (ROSES) omnibus research announcement. All major acquisitions for Rosetta, PDS, and Astromaterials Curation are in place. NEOO data processing nodes are located at the Minor Planet Center (Cambridge, MA) and the Sentry high precision orbit determination node at JPL.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	CAPTEM Panel	11/2010	Curation and Analysis Planning Team for Extraterrestrial Materials (CAPTEM) reviews ongoing curation activities and future plans. Curation of Genesis, Stardust, and Apollo lunar samples are on track and meeting distribution requests. The Curation project is performing well overall. The panel reviewed and approved distribution of samples; reviewed plans for the upgrade of JSC curation facilities; and efforts to work with Constellation on curation of samples on the Moon.	03/2011

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Lunar Quest Program

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**94.5**	**-**	**114.5**	**81.2**	**48.9**	**28.1**	**19.5**
Lunar Science	31.4	-	50.9	48.1	48.9	28.1	19.5
Lunar Atmosphere and Dust Environment Explorer	48.2	-	63.2	33.1	0.0	0.0	0.0
International Lunar Network	14.9	-	0.3	0.0	0.0	0.0	0.0

Note:
The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Program Overview

The Lunar Quest Program (LQP) addresses prioritized science objectives by conducting science exploration of the Moon through research and analysis and through the development of a series of small-medium satellite and possibly surface missions. LQP addresses the science priorities identified in the National Academies report, "The Scientific Context for Exploration of the Moon" (SCEM) and fits within NASA's Space Exploration Policy to scientifically explore the solar system. LQP complements other lunar missions sponsored by NASA and international agencies. LQP objectives are to:

- Provide opportunities to conduct lunar-focused science missions and research;

- Re-establish lunar science and a lunar science community;

- Facilitate the application of enhancing or enabling technologies to support flight missions; and

- Enhance science opportunities in the implementation of NASA's lunar exploration goals.

LQP is a loosely coupled multi-element science program that includes both flight missions and research opportunities. Each LQP project is independent, but they have interrelated objectives and a common management and funding structure. LQP flight opportunities consist of small-medium robotic science spacecraft or landers.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Lunar Quest Program

Plans For FY 2012

LADEE has been confirmed to proceed into implementation phase (key decision point (KDP)-C or KDP-C). The project plans to successfully complete CDR by the end of FY 2011, and plans to start ATLO by the end of FY 2012.

LRO has successfully completed its ESMD objectives and began its science mission in September 2010. The project will continue its science operations and perform data analysis throughout FY 2012.

The Science Mission Directorate/Planetary Science Division will continue to release lunar science research announcements and make research project and grant selections throughout FY 2012.

Project Descriptions and Explanation of Changes

Lunar Science

LQP management provides management and oversight of selected flight missions.

Surface Science Lander Technology and International Lunar Network (ILN)/Decadal Priority consist of continued technology development associated with small lunar landers.

The LRO Science mission will devote the capabilities of its instruments to five scientific topics:

- The bombardment history of the Moon;

- Lunar geologic processes and their role in the evolution of the crust and lithosphere;

- the processes that have shaped the global lunar regolith;

- The types, sources, sinks, and transfer mechanisms associated with volatiles on the Moon; and

- How the space environment interacts with the lunar surface, in order to advance our understanding of the origin and evolution of the Moon.

Lunar R&A will enhance participation and collaboration within the lunar science community. It is composed of competed research and analysis opportunities that include:

- National Lunar Science Institute (NLSI), a virtual institute of geographically dispersed researchers and institutions, directed by the Ames Research Center (ARC) for management and implementation;

- Lunar Advanced Science and Exploration Research (LASER), a lunar-only element in the ROSES NASA Research Announcement (NRA); and

- Lunar Data, which supports lunar data archives and distribution to the science community for analysis.

Lunar Atmosphere and Dust Environment Explorer (LADEE)

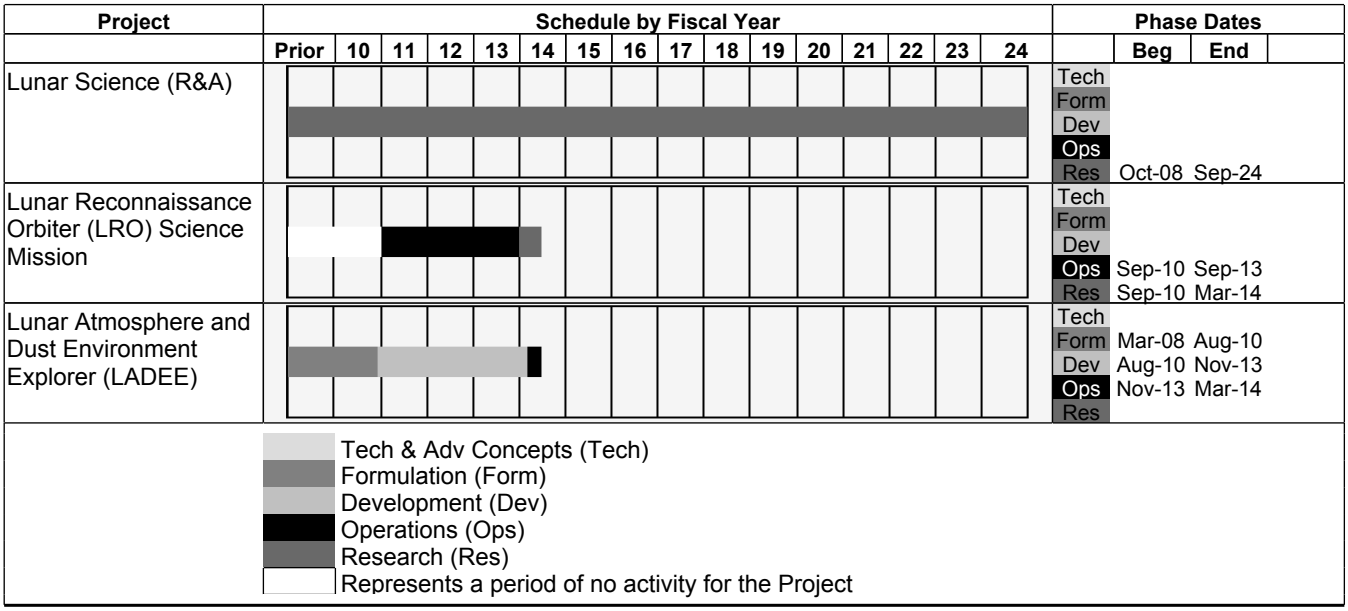
Currently in the implementation phase, LADEE, the first mission developed under LQP, is a cooperative effort between ARC and GSFC. The LADEE mission addresses high priority science goals as identified by the SCEM report, i.e., to determine the global density, composition, and time variability of the fragile lunar atmosphere. LADEE's measurements will also determine the size, charge, and spatial distribution of electrostatically transported dust grains. LADEE will carry the optical laser communications package to be provided by the Space Operations Mission Directorate (SOMD), which will technically demonstrate high bandwidth communication from the Moon. NASA plans to launch LADEE in November 2013. The nominal science mission is 100 days in length. Additional details can be found in the LADEE project development section of this document.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Lunar Quest Program

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Conduct scientific investigations to achieve SMD lunar science goals and objectives in the "Scientific Context for Exploration of the Moon"	Lunar Quest Program	Same
Complete the Lunar Atmosphere and Dust Environment Explorer (LADEE) Systems Integration Review.	LADEE	

Implementation Schedule



Program Management

Scientific mission priorities and assignment responsibilities reside with SMD. Marshall Space Flight Center (MSFC) has LQP management responsibility.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Research & Analysis	HQ	ARC, GSFC, MSFC, JPL, JSC	N/A
LRO Science Mission	GSFC	GSFC, JSC, JPL	N/A
LADEE	ARC	ARC, GSFC/WFF, HQ/USAF	N/A
Surface Science Lander Technology/ILN/Future Decadal Priority	MSFC	MSFC	N/A

Acquisition Strategy

The LQP acquisition strategy is to direct development of flight projects including the spacecraft bus to NASA Centers and competitively select instruments and science team participation through the ROSES NRA, and the Stand Alone Missions of Opportunity (SALMON) NRA.

Major acquisitions for the LADEE, the Surface Science Lander Technology, and the LRO science missions are in place. ARC and GSFC will provide the spacecraft for LADEE. Three science instruments have been selected for LADEE: Neutral Mass Spectrometer (NMS), UV Spectrometer (UVS), and Lunar Dust EXperiment (LDEX). The NMS instrument will be provided by GSFC; ARC will provide UVS; and the University of Colorado/ Laboratory for Atmospheric and Space Physics (LASP) will provide LDEX. MIT/ Lincoln Laboratory (LL) and GSFC will provide the SOMD Lunar Laser Communications Demonstration (LLCD) contribution. USAF/Orbital Sciences will provide the launch services and vehicle.

GSFC will continue to operate the LRO science mission, along with its performing partners (Johns Hopkins University-Applied Physics Laboratory (JHU-APL), JSC, and JPL).

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO	12/2009	Standing Review Board (SRB) was assigned to first perform a Program Acceptance Review (PAR) assessing the program's readiness to enter implementation. Following approval to enter implementation, the SRB will thereafter conduct biannual Program Implementation Reviews (PIRs) throughout implementation to assure the program is operating according to the program plan and that it is successfully meeting the program objectives.	02/2012

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Lunar Quest Program
Project In Development:	Lunar Atmosphere and Dust Environment Explorer

FY 2012 Budget Request

Budget Authority ($ millions)	Prior	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	35.3	48.2	-	63.2	33.1	0.0	0.0	0.0

Note: Consistent with the August 23, 2010 KDP-C decision, funding for SOMD-sponsored Lunar Laser Communications Demonstration (LLCD), $65.3 million, is not included in the above number.

For the FY 2012 Budget Request, project life cycle estimates, required to meet the requirements of section 103 of the NASA Authorization Act of 2005 (P.L. 109-155; 42 U.S.C. 16613), have been consolidated in the Management and Performance Section of this document. This consolidation provides for a comparative analysis across projects, and the inclusion of corrective action plans for the projects that have exceeded their original baseline estimates by greater than fifteen percent.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Explanation of Project Changes

LADEE was confirmed to proceed into development phase on August 23, 2010, supporting a November 2013 launch date. The project's development and life cycle cost estimates and schedule in this document are consistent with the KDP-C memo and its baseline report.

Project Purpose

LADEE, the first mission developed within LQP, is a cooperative effort between ARC and GSFC. LADEE will address high-priority science goals, as identified by the NRC, that determine the global density, composition, and time variability of the fragile lunar atmosphere. LADEE's measurements will also determine the size, charge, and spatial distribution of electrostatically transported dust grains. LADEE will carry an optical laser communications demonstrator to be provided by SOMD. The optical laser will technically demonstrate high-bandwidth communication from the lunar orbit.

Project Parameters

The LADEE spacecraft design is based on a reusable common bus concept, and will be the first spacecraft based on this bus design.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Lunar Quest Program
Project In Development:	Lunar Atmosphere and Dust Environment Explorer

Project Commitments

The spacecraft is planned a near circular, lunar equatorial orbit at approximately 50 km. After launch in November 2013, science operations are planned for 100 days.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Spacecraft	NASA ARC	Small spacecraft based on reusable design	New	Same
Integrated Payload	NASA GSFC	3 science Instruments (UVS, NMS, LDEX)	New	Same
Launch Vehicle	U.S. Air Force's Orbital/Suborbital Program (OSP) Orbital Sciences Corporation	Medium Class/Minotaur V	New	Nomenclature of rocket (IV+ to V)

Schedule Commitments

SMD announced the LADEE project in April 2008 and assigned leadership of the mission to ARC. The LADEE project was confirmed to proceed into development phase on August 23, 2010, supporting a November 2013 launch date.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Development			
KDP-C	08/23/2010	11/2010	08/23/2010
SIR	11/2012	N/A	11/2012
LRD/IOC/IC	11/2013	1/2013	11/2013
End of Prime Mission	03/2014	N/A	03/2014

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Lunar Quest Program
Project In Development:	Lunar Atmosphere and Dust Environment Explorer

Project Management

LADEE operates under the LQP of the SMD Planetary Science Division. The decision authority is the SMD Associate Administrator.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Project Management	Overall, day-to-day management	ARC	N/A
Spacecraft	Design, build and deliver the spacecraft	ARC	N/A
Neutral Mass Spectrometer (NMS) Instrument	Design, build and deliver the NMS instrument. Also responsible for integrating of LDEX and UVS	GSFC	N/A
UV Spectrometer (UVS) Instrument	Design, build, and deliver	ARC	N/A
Lunar Dust EXperiment (LDEX) Instrument	Design, build, and deliver	University of Colorado, LASP	N/A
Launch Vehicle	Integrate vehicle and provide launch service	TBD	N/A

Acquisition Strategy

All major acquisitions are in place. The spacecraft bus was directed to ARC (UVS) in partnership with GSFC (NMS). LDEX was competitively selected through SALMON and awarded to the University of Colorado/LASP. The USAF Orbital/Suborbital Program and Orbital Sciences Corporation are providing the launch vehicle.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SRB	07/2010	Reviewed implementation plan, technical readiness, schedule, costs. Passed Preliminary Design Review (PDR), and confirmed to proceed into implementation phase (C). Critical Design Review (CDR) will be the next independent review.	08/2011

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Lunar Quest Program
Project In Development:	Lunar Atmosphere and Dust Environment Explorer

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Spacecraft design outgrows mass margin allocation	Spacecraft design may outgrow launch vehicle performance if alternative components are required in the spacecraft design as mass margins are extremely limited.	Mitigate through spacecraft design planning, including management of margins and contingencies per LADEE System Engineering Master Plan, carefully watch Min V performance margins through frequent updates from launch vehicle provider.
Minotaur V launch loads unknown	Delay of launch vehicle contract delayed coupled loads analysis which may impact CDR.	Coupled loads analysis is currently under contract for delivery immediately prior to CDR peer reviews. Small residual risk of short delay in CDR.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Discovery

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**184.5**	**-**	**175.6**	**205.1**	**245.7**	**265.5**	**242.8**
Gravity Recovery and Interior Laboratory (GRAIL)	124.1	-	40.5	4.4	0.0	0.0	0.0
Other Missions and Data Analysis	60.4	-	135.1	200.6	245.7	265.5	242.8

Note:
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Program Overview

Robotic space exploration holds tremendous opportunity for exploration and discovery. With the vast amount of knowledge gained since exploration of the solar system began, there come many unanswered questions about the origin and evolution of our own solar system. NASA's Discovery Program provides relatively frequent opportunities to utilize innovative missions that help explain the mysteries of the solar system. It provides highly focused planetary science investigations designed to increase our understanding of the solar system and its evolution. The Discovery Program offers the scientific community the opportunity to assemble and lead cross-functional teams to design and implement exciting science investigations that complement NASA's larger planetary science missions.

Completed Discovery missions have achieved groundbreaking science, with each taking a unique approach to space exploration. Completed missions include: NEAR, Mars Pathfinder, Lunar Prospector, Deep Impact, Stardust, Genesis, Moon Mineralogy Mapper, and EPOXI.

Current Discovery missions continue this approach and include: MESSENGER, Dawn, ASPERA-3, StardustNExT, Exospheric Sampling of Mercury's Surface Composition (Strofio), and Gravity Recovery and Interior Laboratory (GRAIL).

For more information regarding the Discovery Program, see http://discovery.nasa.gov.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Discovery

Plans For FY 2012

The MESSENGER spacecraft completed its third flyby of Mercury in September 2009. It is preparing for its Mercury orbit insertion in March 2011 and will take measurements throughout FY 2012.

The Dawn spacecraft will encounter and orbit Vesta for about ten months, starting in July 2011.

ASPERA-3 continues to collect data on its extended mission aboard ESA Mars Express spacecraft.

The repurposed Stardust NExT mission will approach and accomplish the re-encounter with comet Tempel 1 in February 2011 to detect any changes since the July 2005 Deep Impact mission.

GRAIL will complete ATLO as it prepares for launch, scheduled in September 2011. GRAIL will perform lunar orbit insertion in January 2012, to be followed by science measurements and data analysis.

Project Descriptions and Explanation of Changes

GRAIL

GRAIL was selected in December 2007 and given approval to proceed into its development phase (Phase C) on January 28, 2009. GRAIL continued its implementation phase through FY 2011, is scheduled to launch in September 2011, and will begin its operating phase during FY 2012. GRAIL consists of two spacecraft inserted in low lunar orbit in order to perform high-quality gravity field mapping of the Moon to determine its interior structure. This mission will provide the most accurate global gravity field to date for any planetary body in the solar system, including Earth. GRAIL will enable the public to directly interact with observations through cameras on each dedicated to public outreach and education.

Additional details can be found in the GRAIL development section of this document.

Other Missions and Data Analysis

The Dawn mission, now in its operational phase, is on its journey to the two largest and most massive asteroids in our solar system, Vesta and Ceres. Vesta's physical characteristics reflect those of the inner planets, whereas Ceres' are more like the icy moons of the outer planets. By studying these contrasts and comparing these two minor planets, scientists will develop an understanding of the transition from the rocky inner regions to the icy outer regions of the solar system. The Dawn mission marks the first time a spacecraft will orbit a body in the main asteroid belt and the first time a spacecraft will orbit two sequential targets, enabling a detailed and intensive study of both. Dawn launched in September 2007. The Dawn spacecraft will encounter and orbit Vesta for about ten months starting in July 2011, then after almost a year of Vesta orbit operations, it will travel an additional three years to reach and orbit Ceres.

MESSENGER, a mission to orbit Mercury, launched on August 3, 2004, and will have completed its cruise operations phase and entered Mercury orbit in March 2011. During the three Mercury flybys that prepared the spacecraft for orbit insertion, it collected images that provide coverage of all but two percent of the planet. MESSENGER carries seven scientific instruments and a radio science experiment to accomplish an ambitious objective: return comprehensive data from Mercury orbit for the first time. The miniaturized payload, designed to work in the extreme environment near the Sun, will image all of Mercury for the first time, as well as gather data on the composition and structure of Mercury's crust, its geologic history, the nature of its active magnetosphere and thin atmosphere, and the makeup of its core and the materials near its poles.

As a result of the 2006 Discovery missions of opportunity selected on June 19, 2007, Stardust spacecraft was repurposed for new science missions. The New Exploration of Tempel (NExT) will use the existing Stardust spacecraft for another flyby of comet Tempel 1 in February 2011 in order to image more of the comet's surface and evaluate the extent of surface erosion since the last flyby in FY 2005. The analysis of the returned data will continue through FY 2012.

ASPERA-3, a mission of opportunity, is in a third extension of its operational phase. It is one of seven instruments aboard the ESA Mars Express spacecraft in orbit around Mars, with a goal to study the interaction of the solar wind and Martian atmosphere. The measurements taken by this instrument will help answer the question of how strongly the interplanetary plasma and electromagnetic fields affect the Martian atmosphere.

The M3 project was part of the scientific payload for the ISRO Chandrayaan-1 mission, which launched October 2008 from India, and whose operations were terminated in August 2009. Primary objectives of M3 are to assess the mineral resources of the Moon and characterize and map the composition of the surface at high spatial resolution. The M3 science team will continue to process and analyze the data collected during the shortened mission through FY 2012.

Other Missions & Data Analysis (Continued)

Strofio (Exospheric sampling of Mercury's surface composition), now in its implementation phase, will be part of the ESA mission to Mercury and BepiColombo. Strofio will provide valuable information about Mercury's exosphere and its interaction with the magnetosphere and surface. Strofio completed its confirmation review in May 2010 and is scheduled to deliver in early FY 2012 for launch in August 2014.

The Discovery Research Program supports: Discovery Data Analysis program (DDAP) on archived data collected on Discovery missions; Laboratory Analysis of Returned Samples (LARS), which enables development of new instruments in terrestrial laboratories to analyze samples returned from NASA Planetary Science missions; and participating scientists for the MESSENGER and Dawn missions.

DDAP enhances the scientific return of the completed Discovery missions by broadening the science participation in the analysis of data collected and samples returned. Specifically, the DDAP allows scientists not previously associated with Discovery missions an opportunity to perform analysis of the data archived in the PDS. Data access through Discovery Research allows a much broader, and perhaps more objective, analysis of the data and samples, and also allows research to continue for many years after the mission has been completed. Areas for additional data analyses are proposed by scientists throughout the U.S. planetary community and are competitively selected with major input from science community peer review.

The Discovery Future budget provides funds for future Discovery flight missions to be selected via a competitive announcement of opportunity (AO). The Discovery 2010 AO process will result in selection of a new mission in FY 2012.

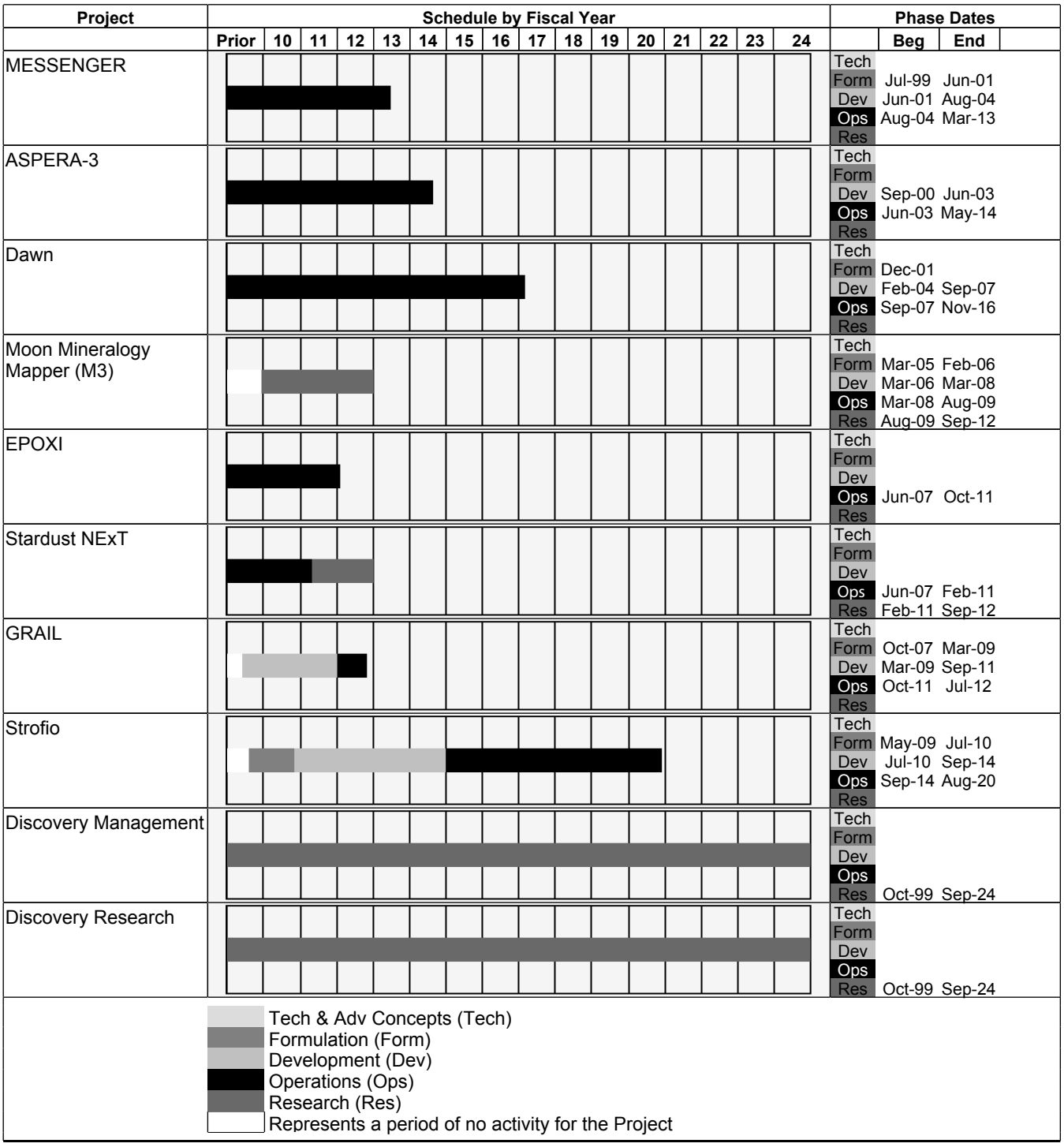
Discovery program management provides for the management oversight of the portfolio of Discovery flight missions in implementation. This line also provides for the development of AOs and supports independent panel reviews and the mission selection process.

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Launch an average of one mission per 24 months	Discovery Program	Same
Complete current prime and funded extended operating missions	Dawn, MESSENGER, ASPERA-3 and StardustNExT	M3 mission ended early due to loss of ISRO's spacecraft; EPOXI mission successfully completed
Complete design and begin spacecraft or instrument development and assembly	Strofio	Same
Complete MESSENGER mission success criteria.	MESSENGER	
Complete the Discovery 12 mission concept studies.	Discovery	

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Discovery

Implementation Schedule



Mission Directorate:	Science
Theme:	Planetary Science
Program:	Discovery

Program Management

MSFC is responsible for Discovery program management. Scientific mission priorities and assignment of responsibilities reside with SMD.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
MESSENGER	Johns Hopkins University-Applied Physics Laboratory (JHU-APL)	GSFC, JPL	None
ASPERA-3	South West Research (SwRI)	MSFC	Sweden; European Space Agency (ESA)
Dawn	JPL	JPL	German Aerospace Center (DLR); Los Alamos National Labs (LANL); Italian Space Agency; and Max-Planck
M3	JPL	JPL	ISRO Chandrayan spacecraft, USGS
Stardust-NExT (Stardust-New Exploration of Tempel)	JPL	JPL	None
GRAIL	JPL	GSFC, JPL, KSC	None
Strofio	SwRI	GSFC	European Space Agency (ESA) BepiColombo Spacecraft

Acquisition Strategy

The Discovery Program solicits proposals for full planetary missions and missions of opportunity. The proposals are put together by teams led by a principal investigator, or PI, and may include firms, small businesses, government and universities. The initial phase of each competitive selection is a concept study, and several missions and missions of opportunity are generally selected for this phase. At the completion of the study phase, one or more concepts may be selected for development, based on their continued scientific merit, technical, management and cost viability, and the availability of funding.

With the exception of future NASA announcements of opportunity, all major acquisitions are in place.

SwRI employs the PI and Lead Scientist for ASPERA-3 and Strofio.

The University of California at Los Angeles sponsors the PI and lead scientist for the Dawn mission.

Brown University sponsors the PI and lead scientist for M3. SAIC, University of Hawaii, and University of Tennessee are also participants.

The Department of Terrestrial Magnetism at the Carnegie Institution of Washington employs the PI and lead scientist for MESSENGER.

Cornell University employs the PI for the Stardust New Exploration of Tempel 1 (NExT) mission of opportunity.

The Massachusetts Institute of Technology (MIT) employs the PI and leads the GRAIL mission.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Discovery

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO	06/2010	Verified compliance with Agency requirements for program implementation and alignment with Agency strategic goals and objectives. Found that the Discovery program provides effective technical and schedule analysis support to the projects and continues to actively use risk-based insight as part of its oversight of the projects. The AO process has proven to be a well-defined, disciplined process that is viewed by the science community as fair and effective.	06/2013

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Discovery
Project In Development:	Gravity Recovery and Interior Laboratory

FY 2012 Budget Request

Budget Authority ($ millions)	Prior	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**221.2**	**124.1**	**-**	**40.5**	**4.4**	**0.0**	**0.0**	**0.0**

Note: For the FY 2012 Budget Request, project life cycle estimates, required to meet the requirements of section 103 of the NASA Authorization Act of 2005 (P.L. 109-155; 42 U.S.C. 16613), have been consolidated in the Management and Performance Section of this document. This consolidation provides for a comparative analysis across projects, and the inclusion of corrective action plans for the projects that have exceeded their original baseline estimates by greater than fifteen percent.

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In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

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Explanation of Project Changes

NASA confirmed GRAIL to proceed into implementation phase (KDP-C or Phase C/D) on January 28, 2009, and entered ATLO in July 2010. GRAIL approved baseline development ($427 million) and the life cycle cost ($496.2 million) numbers remain unchanged since KDP-C.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Discovery
Project In Development:	Gravity Recovery and Interior Laboratory

Project Purpose

GRAIL was selected in December 2007 under the 2006 Discovery AO. The overarching scientific goal of the GRAIL mission is to determine the structure of the lunar interior from crust to core. The GRAIL mission will also advance our understanding of the thermal evolution of the Moon and extend our knowledge gained from the Moon to the other terrestrial-type planets.

GRAIL has six lunar science objectives:

- To map the structure of the crust and lithosphere;

- To study the Moon's asymmetric thermal evolution;

- To determine the subsurface structure of impact basins and the origin and of masons (i.e., high-gravity areas);

- To study the temporal evolution of crustal brecciation and magmatism;

- To study affect on the structure of the deep lunar interior from lunar tides; and

- To understand the size of the possible lunar inner core.

Project Parameters

GRAIL will achieve its science objectives by placing twin spacecraft in a nearly circular low altitude (50 kilometer) polar orbit. The two spacecraft will perform high-precision range-rate measurements between them. Analysis of changes in the spacecraft-to-spacecraft range-rate data caused by gravitational differences will provide direct and high-precision measurements of the lunar gravity. GRAIL will ultimately provide a global, high-accuracy (<10 mGal), high-resolution (30 kilometer) gravity map of the moon. The instrument is based on the successful Earth orbiting Gravity Recovery and Climate Experiment (GRACE) mission.

Project Commitments

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Flight System	Lockheed Martin	2 spacecraft with s/c separation of 175-225 km, conducting 90-day science phase	Same	Same
Lunar Gravity Ranging System	JPL	Ka-band ranging system determines the precise instantaneous relative range-rate of the two s/c	Same	Same
E/PO MoonKam	Sally Ride Science (SRS)	Taking images of the moon, the data will enrich the middle school space science education	Same	Same
Launch Vehicle	ULA	CLIN23 - Delta II Heavy	Same	Same

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Discovery
Project In Development:	Gravity Recovery and Interior Laboratory

Schedule Commitments

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Development			
Development (Phase C/D or KDP-C)	January 28, 2009	Same	Same
Critical Design Review (CDR)	November 2009	Same	Same
System Integration Review	June 2010	June 2010	Same
Launch Readiness Review	September 2011	Same	Same
End of Prime Mission	June 2012	same	same

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Discovery
Project In Development:	Gravity Recovery and Interior Laboratory

Project Management

GRAIL is part of the Discovery program managed by MSFC. The PI from MIT has delegated day-to-day project management to JPL.

Acquisition Strategy

GRAIL was selected competitively on December 13, 2007, under a Discovery program AO (AO-NNH06ZDA001O).

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SRB/IPAO	05/2010	Assess cost, schedule, and risk status of the project. The findings for the review showed that cost and schedule for the 2011 launch are consistent with the project's plans.	06/2011

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Single String Spacecraft	Both GRAIL spacecraft are primarily single string for major components. If there is an in flight failure, then there is no ability to switch over to a total redundant component.	The mission is of relatively short duration and the single string risks are mitigated by use of proven designs, high reliability parts, and additional testing of critical systems, consistent with the cost and schedule constraints of the project.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**279.6**	**-**	**176.9**	**265.8**	**245.5**	**291.1**	**296.3**
Juno	257.1	-	31.2	17.6	17.9	16.7	29.6
Other Missions and Data Analysis	22.4	-	145.7	248.2	227.6	274.4	266.7

Note: The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Program Overview

The New Frontiers Program, comprised of medium to large-sized missions, constitutes a critical element of NASA's solar system exploration capability that will perform high-quality focused scientific investigations. Initiated in 2003, the New Frontiers program was defined to pursue high-quality planetary missions that require resources beyond those available in the Discovery Program. Unlike the Discovery Program, the choice of destinations and the science goals for each New Frontiers opportunity are limited to the NRC recommended science targets. The National Academies-recommended science targets for the New Frontiers program include Pluto and the Kuiper Belt, Jupiter, Venus, Io, Ganymede, Trojan/Centaurs, and sample returns from Earth's Moon, an asteroid, and a comet nucleus.

New Horizons is currently on its way to its primary target, Pluto, and is the first peer-review selected mission of the New Frontiers program. It will conduct reconnaissance of Pluto and its moons Charon, Nixa, and Hydra. The dwarf planet Pluto has been revealed to be a multi-object system of small and large moons, never before seen up close. This mission will tell us a lot about how the Kuiper belt orbits form and their role in the early formation of the solar system.

Juno, the second New Frontiers mission with an overarching scientific goal to understand the origin and evolution of Jupiter and planetary formation, is currently under development. The third New Frontiers AO was released in April 2009. Three mission concept studies were awarded on December 29, 2009. Selection of the final mission is expected by the end of CY 2011, allowing the New Frontiers 3 mission to proceed into Phase B in FY 2012.

For more information on the New Frontiers program, see http://newfrontiers.nasa.gov/index.html.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers

Plans For FY 2012

The Juno mission continues its ATLO (Phase D) phase. All Juno mission hardware will be fully tested and be delivered to Cape Canaveral in preparation for a launch in August 2011. The project will spend five years cruising toward Jupiter as it periodically performs deep space maneuvers and instrument checkouts.

The New Horizons spacecraft remains on track for a July 2015 arrival at Pluto. The project will continue its cruise period throughout FY 2012. Work during the cruise period will include annual spacecraft and instrument checkouts and dress rehearsals for the Pluto flyby.

The third New Frontiers AO was released in April 2009. Selection of New Frontiers 3 proposals for funded mission Phase A concept studies occurred on December 29, 2009. Down-selection of one mission to proceed to the subsequent phases is expected in third quarter to late CY 2011. The project will then proceed to Phase B in FY 2012.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers

Project Descriptions and Explanation of Changes

Juno

Juno, now in ATLO (Phase D), is a mission to Jupiter scheduled to launch in August 2011. The Juno science goals are to: determine the oxygen to hydrogen ratio to determine water abundance and estimate core mass in order to decide among alternative theories of planetary origin; understand Jupiter's interior structure and dynamic properties, including internal convection and the size and mass of its core, through mapping of its gravitational and magnetic fields with unprecedented accuracy; map variations in atmospheric composition, temperature, cloud opacity and dynamics to depths greater than 100 bars at all latitudes; and characterize and explore the three-dimensional structure of Jupiter's polar magnetosphere and auroras. Juno uses a simple, spin-stabilized spacecraft in an elliptical polar orbit that minimizes radiation exposure by flying under Jupiter's radiation belts at perijove and outside them at apojove. Juno's baseline orbit remains continuously in sunlight, resulting in benign and stable thermal conditions. Spin stability eliminates complex, power-hungry attitude control components such as reaction wheels.
Additional detail can be found in the Juno project development section of this document and at http://newfrontiers.nasa.gov/missions_juno.html.

Other Missions and Data Analysis

The New Frontiers Future project provides funds for future New Frontiers space missions to be selected via a competitive AO process. The third announcement of opportunity (NF-3) was released for competition in April 2009. The science targets for this NF-3 AO are those identified in the National Academies' report, "Opening New Frontiers in Space: Choices for the Next New Frontiers Announcement of Opportunity" (2008). Three mission concept studies were awarded on December 29, 2009. These concept missions probe the atmosphere and crust of Venus; return a piece of a near-Earth asteroid for analysis; or drop a robotic lander into a basin at the moon's south pole to return lunar rocks back to Earth for study. The 12-month studies began during 2010, and the selected mission must be ready for launch no later than December 30, 2018. Down-selection to one mission is currently planned for third quarter to late CY 2011.

New Frontiers Research provides for the Jupiter Data Analysis project (JDAP), which broadens the science community participation in the analysis of mission data, and allows scientists outside the selected flight team to analyze the data from the mission, do research, and publish their findings. Data access through the New Frontiers Research project allows a much broader and perhaps more objective, analysis of data and samples. JDAP also facilitates new ideas and approaches, getting young people started in science, and broadening participation to get a critical mass of scientific talent working on mission data at the critical time.

On January 19, 2006, the New Horizons mission successfully launched on an Atlas V launch vehicle. New Horizons will reach Pluto and its moons, Charon, Nixa, and Hydra, in July 2015. New Horizons will conduct a reconnaissance of the Pluto-Charon system, map their surface composition and surface temperatures, characterize their geology and the atmosphere of Pluto, search for any atmosphere around Charon, and search for rings and additional satellites around Pluto. The New Horizons spacecraft is now halfway between Earth and Pluto, on approach for a dramatic flight past the icy planet and its moons in July 2015.

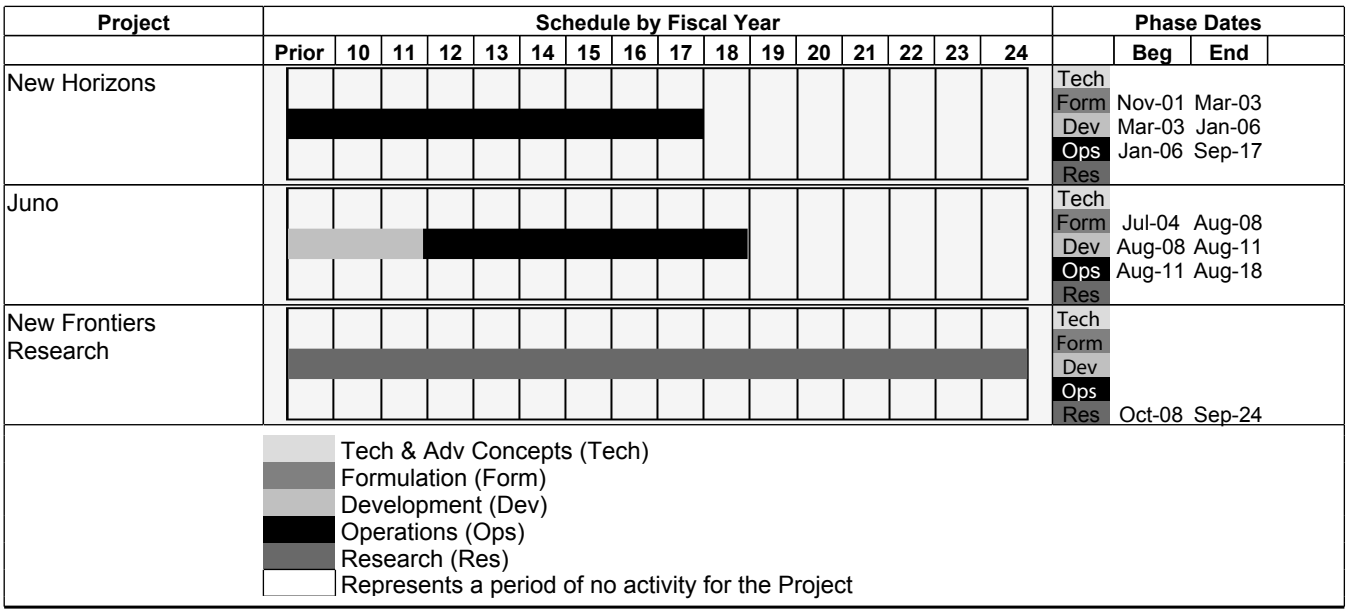
New Frontiers program management provides for management oversight of flight missions in implementation, development of AOs, assessments for new missions, and independent management reviews.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Launch an average of one mission per 52 months	New Frontiers program	same
Complete the mission concept studies for the New Frontiers 3 mission.	New Frontiers 3	

Implementation Schedule



Program Management

MSFC has New Frontiers program management responsibility. Scientific mission priorities and assignment of responsibilities reside with SMD.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
New Horizons	MSFC	GSFC, JPL	None
Juno	MSFC	JPL, KSC, GSFC	Italian Space Agency (ASI)
New Frontiers Research	HQ	Multi-Center	None

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers

Acquisition Strategy

Future acquisitions of New Frontiers missions occur under open AO competitions. The New Frontiers Program solicits proposals for an entire mission (including instruments). Proposals are put together by teams, led by a PI, and include contributions from industry, small businesses, government, and academia.

Major acquisitions for the New Horizons (JHU-APL) and Juno (JPL) projects are in place. The PI for New Horizons is at SwRI in Boulder, CO. JHU-APL has project management responsibility.

The Juno PI is from SwRI in San Antonio, TX. JPL provides mission project management and Lockheed Martin Space Systems is building the spacecraft. The Italian Space Agency, ASI, is contributing the Ka-band translator and infrared spectrometer instrument.

New Frontiers Research will be competitively selected from proposals received in response to the ROSES NRA.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO	06/2010	Verified compliance with Agency requirements for program implementation and alignment with Agency strategic goals and objectives. The findings from the review include: the program provides effective technical and schedule analysis support to the projects and continues to actively use risk-based insight as part of its oversight of the projects, and that the AO process has proven to be a well-defined, disciplined process that is viewed by the science community as fair and effective.	06/2013

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers
Project In Development:	Juno

FY 2012 Budget Request

Budget Authority ($ millions)	Prior	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**485.9**	**257.1**	**-**	**31.2**	**17.6**	**17.9**	**16.7**	**29.6**

Note: Other than the rephasing adjustments, the project remains within its life cycle ($1,107 million) and development ($742.3 million) baseline cost estimates.

For the FY 2012 Budget Request, project life cycle estimates, required to meet the requirements of section 103 of the NASA Authorization Act of 2005 (P.L. 109-155; 42 U.S.C. 16613), have been consolidated in the Management and Performance Section of this document. This consolidation provides for a comparative analysis across projects, and the inclusion of corrective action plans for the projects that have exceeded their original baseline estimates by greater than fifteen percent.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

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Explanation of Project Changes

The funding profile has been modified consistent with NASA risk management plan and strategy. There are no changes to the Juno approved development ($742.3 million) nor the life cycle cost ($1,107 million) baselines since KDP-C.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers
Project In Development:	Juno

Project Purpose

NASA selected Juno on July 15, 2005, under the New Frontiers AO. The overarching scientific goal of the Juno mission is to improve understanding of the origin and evolution of Jupiter. However, as the archetype of giant planets, Jupiter can also provide knowledge that will improve understanding of both the origin of our solar system and of planetary systems being discovered around other stars. The investigation focuses on four science objectives.

Origin: Determine the oxygen-to-hydrogen ratio to determine water abundance and estimate core mass to decide among alternative theories of planetary origin.

Interior: Understand Jupiter's interior structure and dynamic properties through mapping of its gravitational and magnetic fields with unprecedented accuracy, leading to observations of internal convection and the size and mass of its core.

Atmosphere: Map variations in atmospheric composition, temperature, and cloud opacity and dynamics, to depths greater than 100 bars, at all latitudes.

Magnetosphere: Characterize and explore the three-dimensional structure of Jupiter's polar magnetosphere and auroras.

These objectives have been rated very highly in the National Academies' Solar System Exploration decadal survey and Sun-Earth Connections decadal survey. The Astrophysics decadal survey identified the study of star formation, their planetary systems, as well as giant and terrestrial planet birth and evolution as high priority. Juno fulfills key goals outlined in recent NASA and NRC studies.

Project Parameters

Juno achieves the science objectives by using a simple spinning, solar-powered spacecraft to make global maps of the gravity, magnetic fields, and atmospheric composition of Jupiter from a unique elliptical polar orbit with a close perijove. The spacecraft carries precise, high-sensitivity radiometers, magnetometers, and gravity science systems. Juno's 32 polar orbits extensively sample Jupiter's full range of latitudes and longitudes. From its polar perspective, Juno combines in-situ and remote sensing observations to explore the polar magnetosphere and determine the composition and phenomena of Jupiter's auroras.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers
Project In Development:	Juno

Project Commitments

The Juno launch date is August 2011. After a five-year cruise to Jupiter, Juno will enter Jupiter orbit insertion (JOI) during August 2016. Juno will perform one year of science operations.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Waves	University of Iowa	Measures radio and plasma emissions; 4 m electric dipole and search coil	Same	Same
Jupiter Energetic particle Detector Instrument (JEDI)	John Hopkins Applied Physics Lab (JHU-APL)	Measures auroral distributions of electrons and ions; TOF vs. energy, and ion & electron sensors	Same	Same
Gravity Science	Jet Propulsion Lab (JPL)	Maps Jupiter's gravitational field to determine structure of core; X and Ka-band precision Doppler	Same	Same
Flux-Gate Magnetometer (FGM)	GSFC	Maps Jupiter's magnetic field (Vector)	Same	Same
Launch Vehicle	KSC	Atlas 551	Same	Same
UV Spectrometer (UVS)	Southwest Research Institute (SwRI)	FUV spectral imager for auroral emissions	Same	Same
Microwave Radiometer (MWR)	Jet Propulsion Lab (JPL)	6 wavelengths (1.3-50 cm); sounds atmosphere to determine water and ammonia abundances	Same	Same
Spacecraft	Lockheed Martin	Solar-powered, spin-stabilized spacecraft in an elliptical polar orbit that minimizes radiation exposure	Same	Same
Jovian Auroral Distributions Experiment (JADE)	Southwest Research Institute (SwRI)	Ion mass spectrometer and electron analyzers; measures auroral distributions of electrons and ions	Same	Same
Juno Camera (JunoCam)	Malin Space Studies Institute	EPO instrument that will take auroral images and Jovian atmospheric activity	Same	Same

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers
Project In Development:	Juno

Schedule Commitments

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Formulation			
PDR	5/2008	same	same
Development			
CDR	3/2009	4/2009	same
SIR (formerly ATLO)	3/2010	same	4/2010
FRR	7/2011	same	same
Launch	8/2011	same	same
End of Prime Mission	10/2017	same	same

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers
Project In Development:	Juno

Project Management

Juno is part of the New Frontiers program, with program management at MSFC. The PI, from SwRI, has delegated day-to-day Juno project management to JPL.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Project Management	Project Management and Oversight	JPL	N/A
Jupiter energetic particle instrument (JEDI)	Jet Propulsion Lab (JPL)	None	None
Plasma Waves Experiment (WAVE)	Jet Propulsion Lab (JPL)	None	None
Management; Microwave radiometer, and Gravity Science Experiment	MSFC/New Frontiers Program Office		None
Vector Fluxgate Magnetometer (FGM)	Jet Propulsion Lab (JPL)	Goddard Space Flight Center (GSFC)	None
UVS and JADE instruments	JPL/Juno Project Office	JPL	None
Flight System, Integration and Test	Jet Propulsion Lab (JPL)	None	None
Overall responsibility for the development, implementation, operation, and success of the mission	MSFC/New Frontiers Program Office	None	None
JunoCam	Jet Propulsion Lab (JPL)	None	None
KaBand and IR science	Jet Propulsion Lab (JPL)	None	Italian Space Agency (ASI)

Acquisition Strategy

All major acquisitions are in place. Juno was selected competitively on July 15, 2005 under the second New Frontiers program AO (AO-03-OSS-03).

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO /SRB	03/2010	Assess cost, schedule, and risk status of project. The findings from the review showed that cost and schedule for the August 2011 launch are consistent with the project's plans. The project received approval to proceed to ATLO.	06/2011

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers
Project In Development:	Juno

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Jupiter orbit insertion	If Jupiter orbit insertion fails to put the spacecraft in the desired orbit, then science goals will not be obtainable.	Review baseline Phase E plan and compare with previously flown missions. Develop a recommended operational approach consistent with a Category 1, Class B mission to minimize the risk of an orbital insertion anomaly.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**438.2**	**-**	**594.4**	**433.1**	**408.7**	**309.0**	**245.9**
2009 Mars Science Lab	258.4	-	136.4	40.5	37.0	0.0	0.0
MAVEN	48.1	-	240.3	140.6	34.9	15.4	4.7
Other Missions and Data Analysis	131.7	-	217.7	252.0	336.8	293.5	241.1

Note:
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Program Overview

Mars is the most Earth-like planet in the solar system, with land mass approximately equivalent to the Earth's, and having familiar features such as riverbeds, past river deltas, and volcanoes. Mars has the best planetary record of the first billion years of our solar system and holds scientific clues to the development of the solar system, planets, and maybe life itself. The Mars Exploration Program has been developed to conduct a rigorous, incremental, discovery-driven exploration of Mars to determine the planet's physical, dynamic, and geological characteristics.

The twin Mars rovers, Spirit and Opportunity, are seven years into their surface exploration of Mars, and they continue to return a wealth of new results. Opportunity has been moving south to Endurance Crater, twenty times larger than Victoria Crater. Spirit has been conducting further studies in the area of what remains of an ancient hydrothermal system. Although Spirit is hibernating, NASA has an in situ science plan should the rover survive the winter. The Mars Reconnaissance Orbiter (MRO) is in its extended mission operations phase and is continuing to return results highlighting areas showing morphological, and mineralogical evidence of interaction with liquid water, and characterizing landing sites for MSL and future missions. Mars Odyssey's Thermal Emission Imaging System (THEMIS) has found new evidence of evaporites (salt deposits). Meanwhile, the Mars Science Laboratory (MSL) mission continues to achieve technical and schedule progress toward the CY 2011 launch opportunity. MAVEN is the second Mars Scout mission and will study atmospheric processes that will lead to understanding the evolution of the Martian atmosphere. The 2016 ExoMars Trace Gas Orbiter (EMTGO), the first mission in the joint Mars Exploration program between ESA and NASA, will investigate the constituency, sources and processes of trace gases at Mars including methane, as well as refresh the existing telecommunications infrastructure at Mars for any orbital and surface missions to Mars after 2016.

For more information, see http://mars.jpl.nasa.gov.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration

Plans For FY 2012

The MSL cruise stage and the rover are scheduled for delivery to the KSC in June to support a launch in November 2011. MSL will spend most of FY 2012 cruising toward its destination, and is scheduled to land on the surface of Mars in August 2012 where it will start surface science operations.

MAVEN successfully completed PDR and has been confirmed to proceed into implementation phase (Phase C/D). Additionally, the project plans to complete CDR by the end of FY 2011. Project managers will work toward System Integration Review to enable approval to enter Phase D, including Operational and Flight Readiness Reviews, by the end of FY 2012.

MER, MRO, Odyssey, and ESA's Mars Express will continue to operate, return science data and perform telecom and relay support throughout FY 2012.

NASA selected four instruments to be included in the NASA/ESA 2016 EMTGO in August 2010. The project plans to successfully complete NASA's PDR by end of FY 2011, and will work toward achieving a successful CDR by the end of FY 2012.

Project Descriptions and Explanation of Changes

Mars Science Laboratory (MSL)

Currently in its implementation phase, MSL takes a major step forward in Mars exploration, both technically and scientifically, utilizing a new entry, descent, and landing system, a long-duration rover, and ten payload elements for definitive mineralogical and organics measurements. The primary scientific objective is to explore and quantitatively assess a local region on Mars as a potential habitat for life, and is the transitional mission from the "Follow the Water" theme to "Seeking the Signs of Life" theme. MSL will lay the groundwork for future scientific missions, including Mars Sample Return, and will provide key information for human exploration. Additional detail can be found in the MSL project development section of this document.

Mars Atmosphere and Volatile EvolutioN (MAVEN)

NASA's second Mars Scout mission, MAVEN (openly competed, PI-led), was approved for implementation (Phase C) beginning November 2010. MAVEN, a robotic orbiter mission, will provide a comprehensive study of the Mars upper atmosphere, ionosphere, solar energetic drivers, and atmospheric losses. It will deliver key measurements addressing longstanding questions about the climate history and habitability of Mars. GSFC will manage the project. Lockheed Martin of Littleton, CO, will build the spacecraft based on designs from NASA's Mars Reconnaissance Orbiter and 2001 Mars Odyssey missions. Additional detail can be found in the MAVEN project section of this document.

Other Missions & Data Analysis

In its extended mission operation phase, the primary scientific objectives of Odyssey include more sensitive measurement of the mineralogy of the surface, monitoring of inter-annual variations of Mars climate and surface processes, acquiring future mission landing site data, and continuing as a key telecommunications relay at Mars.

Currently in their extended operation phase, both the Spirit and Opportunity rovers continue to explore geological settings on the surface of Mars using a suite of remote sensing and in-situ instruments. Their objective is to expand our understanding of the history and the geological processes that shaped Mars, particularly those involving water.

Currently in its extended mission operation phase, the objective of the ESA and ISA Mars Express mission is to search for sub-surface water from orbit. NASA participates in the scientific analysis of mission data, including the recent investigations into the mysterious and perhaps the youngest deposits of the Medusae Fossae formation that have minimal radar signal.

Currently in its extended operation phase, MRO's science objectives include: providing high resolution spectral maps and images for interpretation of the geology of the Martian crust; using ground-penetrating radar to map compositional discontinuities and layering under the surface; and creating planetary-scale maps of critical atmospheric properties. MRO has been critical in characterizing landing sites for MSL and will be instrumental in identifying them for future landed missions as well. MRO is also the key telecommunications relay for the first half of the next decade at Mars.

Mars Mission Operations (MMO) provides management and leadership for the development and execution of Mars multi-mission operations. MMO supports and provides operational capabilities at a lower cost and risk to all current Mars projects.

Once missions have concluded their primary mission phase, further funding for extended operations is allocated based on the findings of a senior review board. Their review of each mission enables them to make recommendations for the allocation of the extended operations budget based on scientific merit.

NASA invests in research and analysis of Mars mission data in order to understand how geologic, climatic, and other processes have worked to shape Mars and its environment over time, as well as how they interact today.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
MEP will provide continual operational presence on Mars	Mars Exploration	Same
At least one Mars mission will be launched at every opportunity (every 26 months)	Mars Exploration	Same
Complete the Mars Science Laboratory (MSL) Launch Readiness Review.	MSL	
Complete the Mars Atmosphere and Volatile EvolutioN Mission (MAVEN) Systems Integration Review.	MAVEN	
Complete the Mars 16 Mission Confirmation Review.	Mars Exploration	

Implementation Schedule

Project	Schedule by Fiscal Year																Phase Dates		
	Prior	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24		Beg	End
Mars Odyssey																	Tech		
																	Form	Apr-97	Apr-99
																	Dev	Apr-99	Apr-01
																	Ops	Apr-01	Sep-12
																	Res		
Mars Exploration Rovers (Spirit and Opportunity)																	Tech		
																	Form	May-00	Aug-01
																	Dev	Aug-01	Jun-03
																	Ops	Jun-03	Sep-12
																	Res		
Mars Reconnaissance Orbiter (MRO)																	Tech		
																	Form	Jan-01	Jul-02
																	Dev	Jul-02	Aug-05
																	Ops	Aug-05	Sep-11
																	Res	Oct-11	Sep-17
Mars Science Laboratory (MSL)																	Tech		
																	Form	Nov-03	Aug-06
																	Dev	Aug-06	Dec-11
																	Ops	Dec-11	Oct-13
																	Res	Oct-13	Oct-17
Mars Express																	Tech		
																	Form	Jan-00	Sep-00
																	Dev	Sep-00	Jun-03
																	Ops	Jun-03	Dec-05
																	Res	Dec-05	May-14
The Mars Atmosphere and Volatile EvolutioN (MAVEN)																	Tech		
																	Form	Sep-08	Sep-10
																	Dev	Sep-10	Nov-13
																	Ops	Nov-13	Dec-14
																	Res	Dec-14	Jul-16
Mars R&A																	Tech		
																	Form		
																	Dev		
																	Ops		
																	Res	Oct-00	Sep-24

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration

Program Management

JPL has responsibility for implementation of the Mars Exploration program. Scientific mission priorities and assignment of responsibilities reside with SMD.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Mars Exploration Rovers (MER)	JPL	JPL, ARC, GRC, JSC, GSFC	None
Mars Reconnaissance Orbiter (MRO)	JPL	JPL, ARC, GSFC, JSC, MSFC	Agenzia Spaziale Italiana (ASI)
Mars Science Laboratory (MSL)	JPL	JPL , ARC, GSFC, KSC, GRC, LaRC, JSC	Department of Energy; International partners include Canada, Spain, and Russia.
Mars Atmosphere and Volatile EvolutioN (MAVEN)	JPL	GSFC, KSC, JPL	Centre d'Etude Spatiale des Rayonnements (CESR)
Mars Odyssey	JPL	JPL, MSFC	None
Mars Express (MEX)	JPL	JPL, GSFC	European Space Agency (ESA)
2016 ExoMars Trace Gas Orbiter (EMTGO)	JPL	JPL, ARC, LaRC, GSFC,KSC	European Space Agency (ESA)

Acquisition Strategy

The Mars Exploration program has set a goal of open competition for all missions.

All major acquisitions for MSL are in place. Malin Space Systems, Honeybee Robotics, Lockheed Martin, and Aeroflex are providing support and hardware for the MSL mission.

For the MAVEN mission, the PI is Dr. Bruce Jakosky of the Laboratory for Atmospheric and Space Physics at the University of Colorado at Boulder. GSFC will manage the project, and Lockheed Martin of Littleton, CO, will build the spacecraft.

All Mars research is procured through the ROSES announcement and a competitive, peer review selection process.

Instruments for the 2016 EMTGO were competitively selected via an AO process. ESA will provide the spacecraft, and NASA will provide the launch vehicle. JPL will provide project management and implement the ESA/NASA contributions.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO	10/2006	A Program Implementation Review was conducted in October 2006. Review determined the Mars program was functioning well and continuing to make important contributions to science, but was short on reserve funding. It also found that MSL is critical for future mission science and technology.	3/2011
All	Senior Review Panel	03/2010	Comparative review of Mars operating missions. Missions are ranked in terms of science, engineering capability, and their programmatic roles as they relate to the Mars Exploration program. The findings lead to mission extension for Odyssey, MER, MEX, and MRO, with orbit time change for the Mars Odyssey mission.	03/2012

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Development:	2009 Mars Science Lab

FY 2012 Budget Request

Budget Authority ($ millions)	Prior	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**1,744.4**	**258.4**	**-**	**136.4**	**40.5**	**37.0**	**0.0**	**0.0**

Note: Consistent with the SRB, the Directorate Program Management Council and December 9, 2010 Aeropropulsion Management Council recommendations, this budget request includes additional funds to rebuild reserves to a level sufficient to assure the project will achieve its November Launch Readiness Date. This is required due to depletion of reserves in FY 2010, as the cost for final development of the MSL subsystem (avionics, mobility system and drill) and ensuring timely completion of science instruments exceeded expectations.

For the FY 2012 Budget Request, project life cycle estimates, required to meet the requirements of section 103 of the NASA Authorization Act of 2005 (P.L. 109-155; 42 U.S.C. 16613), have been consolidated in the Management and Performance Section of this document. This consolidation provides for a comparative analysis across projects, and the inclusion of corrective action plans for the projects that have exceeded their original baseline estimates by greater than fifteen percent.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Explanation of Project Changes

The project continues to make technical, cost, and schedule progress. The Sample Analysis of Mars (SAM) instrument has been delivered to the project and difficulties are being resolved for Sample Acquisition, Processing, and Handling (SA/SPaH) drill. To ensure mission success, NASA continues to adopt more conservative posture consistent with NASA risk management plan and strategy. The current life cycle cost is estimated at $2,476.3 million. NASA anticipates reprogramming additional funds to MSL in the initial FY 2011 operating plan to address the technical problems and related issues that have occurred during assembly and testing. The project remains on track to meet its November 2011 launch readiness date (LRD).

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Development:	2009 Mars Science Lab

Project Purpose

The Mars Science Laboratory (MSL) mission is the most technologically challenging interplanetary rover ever designed. It will use new technologies to adjust its flight while descending through the Martian atmosphere, and to set the rover on the surface by lowering it on a tether from a hovering descent stage. Advanced research instruments make up a science payload ten times the mass of instruments on NASA's Spirit and Opportunity Mars rovers. MSL is engineered to drive longer distances over rougher terrain than previous rovers. It will also employ a new surface propulsion system.

MSL will make detailed measurements of element composition, elemental isotopes and abundance, mineralogy, and organic compounds to determine if Mars has, or ever had an environment capable of supporting life within the regions explored by MSL.

MSL has four science objectives:

- Assess the biological potential of at least one selected site on Mars;

- Characterize the geology and geochemistry of the landing region at all appropriate spatial scales;

- Identify planetary processes relevant to past habitability; and

- Characterize the broad spectrum of the Martian surface radiation environment.

For more information, see the MSL homepage at
http://marsprogram.jpl.nasa.gov/missions/future/msl.html.

Project Parameters

The MSL is a surface rover that will collect Martian soil and rock samples and analyze them for organic compounds and environmental conditions that could have supported microbial life now or in the past. MSL will be a long-duration (two years) roving science laboratory that will be twice as long and four times as heavy (900 kilograms) as the Mars Exploration Rovers, Spirit and Opportunity.

Key technologies developed for MSL include: throttle-controlled, high-thrust engines, required during Martian entry, descent, and landing (EDL); sample acquisition and processing equipment used to acquire and distribute samples to the analytic instrument suite; and long-life, high-reliability, thermal-cycle-resistant electronics for use in the rover.

The EDL system will accommodate a wide range of possible latitude and altitude locations on Mars in order to be discovery-responsive and to have the capability to reach very promising, but difficult-to-reach scientific sites.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Development:	2009 Mars Science Lab

Project Commitments

MSL will be ready to launch in November 2011 and will arrive at Mars approximately nine months (August 2012) later. MSL will operate for two Earth years on the surface of Mars and will travel approximately 20 kilometers on the Martian surface.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Rover	JPL	Travel 20 kilometers over the Martian surface.	Same	Same
Stereoscopic and microscopic cameras	Malin Space Systems	Acquire color, stereo images with resolutions up to 0.2 mm/pixel at 2 m range.	Same	Added MastCam zoom capability
Robotic arm tools	Honeybee Robotics	Acquire, process and deliver 75 rock and soil samples to analytic instruments.	Changed the rock grinder to a brush, sample quantity unchanged acquired by drill.	Same
Chemistry camera (ChemCam)	Department of Energy/Los Alamos National Laboratory; France	Remotely measure elemental composition of rocks and soil up to 9m from rover.	Same	Same
Alpha Particle X-ray Spectrometer	Canada (CSA)	Measure with high precision the elemental composition of in situ rocks and soil.	Same	Same
Rover Environmental Monitoring System (REMS)	Spain	Monitor key atmospheric measurements including temperature, pressure, wind speed/direction and humidity.	Same	Same
Dynamic Albedo of Neutrons (DAN)	Russia (IKI)	Measure hydrogen content in subsurface deposits.	Same	Same
Cruise stage and entry system	Lockheed Martin	Transport rover to Martian surface and land with impact speed below 1 m/s	Same	Same
Mission operations and data archive	JPL	Conduct one-year cruise and two-year rover primary mission with remotely located science team.	Same	Same
Sample Analysis at Mars (SAM)	NASA/GSFC	Analysis of elemental and isotopic composition of Mars samples	Same	Same
Sample Cache	ARC	Hockey puck-sized container will collect sample of Martian soil for possible later collection by a Mars sample return mission.	Deleted	Same
Chemistry and Mineralogy Instrument (CheMin)	NASA/ARC	Analysis of mineral and chemical content of Mars samples	Same	Same

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Development:	2009 Mars Science Lab

Schedule Commitments

MSL entered formulation phase in November 2004 and proceeded into implementation phase in August 2006. The project is currently scheduled for launch in November 2011, to be followed by landing and surface science operations beginning in August 2012.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Development			
Critical Design Review	June 2007	June 2007	Same
System Integration Review (formerly ATLO)	February 2008	February 2008	Same
Launch Readiness Review	September 2009	4QTR CY 2011	Same

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Development:	2009 Mars Science Lab

Project Management

MSL is a JPL-managed in-house project. Instrument implementation has been assigned to JPL.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Rover	JPL	JPL	None
Stereoscopic and microscopic cameras	JPL	None	None
Robotic arm tools	JPL	JPL	None
Chemistry camera (ChemCam)	JPL	None	Department of Energy and France
Alpha Particle X-ray Spectrometer	JPL	None	Canada
Rover Environmental Monitoring System (REMS)	JPL	None	Spain
Dynamic Albedo of Neutrons (DAN)	JPL	None	Russia
Cruise stage and entry system	JPL	JPL, AMES, LaRC	None
Spacecraft	JPL	JPL	None
Sample Analysis at Mars (SAM)	JPL	GSFC	CNES (France)
Chemistry and Mineralogy Instrument (CheMin)	JPL	ARC	None

Acquisition Strategy

All major acquisitions are in place. All major instruments were competitively selected. Malin Space Systems, Honeybee Robotics, Lockheed Martin, and Aeroflex are providing support and hardware for the MSL mission.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	HQ/SRB	11/2010	Assess maturity of MSL design, technical state, and adequacy of resources. Design was deemed adequate to achieve mission science goals, but project needs additional time and resources to work the technical problems and perform adequate testing. The finding resulted in an additional $82.11 million, consistent with NASA risk management plan and strategy, to resolve problems and to ensure mission success.	03/2011

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Development:	2009 Mars Science Lab

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
MSL Landing Risk	If the MSL spacecraft does not successfully land on the Martian surface, then the science objectives will not be achieved.	To ensure success, conduct thorough verification and validation program that includes simulations of trajectory, approach, and landing operations to validate and refine procedures, and apply lessons learned from Phoenix and MER.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Development:	Mars Atmosphere & Volatile EvolutioN

FY 2012 Budget Request

Budget Authority ($ millions)	Prior	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**9.9**	**48.1**	**-**	**240.3**	**140.6**	**34.9**	**15.4**	**4.7**

Note: For the FY 2012 Budget Request, project life cycle estimates, required to meet the requirements of section 103 of the NASA Authorization Act of 2005 (P.L. 109-155; 42 U.S.C. 16613), have been consolidated in the Management and Performance section of this document. This consolidation provides for a comparative analysis across projects, and the inclusion of corrective action plans for the projects that have exceeded their original baseline estimates by greater than fifteen percent.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

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Explanation of Project Changes

MAVEN received KDP-C decision approval on October 4, 2010. The above funding estimate reflects the October 2010 KDP-C decision, which included Electra and the awarded launch vehicle costs.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Development:	Mars Atmosphere & Volatile EvolutioN

Project Purpose

Mars Atmosphere and Volatile EvolutioN (MAVEN) was selected in September 2008 under the 2006 Mars Scout AO. The MAVEN mission will provide a comprehensive picture of the Mars upper atmosphere, ionosphere, solar energetic drivers, and atmospheric losses. MAVEN will deliver answers to long-standing questions regarding the loss of Mars' atmosphere, climate history, liquid water, and habitability. MAVEN will provide the first direct measurements ever taken to address key scientific questions about Mars' evolution.

Specific MAVEN science objectives are to:

- Determine structure and composition of the atmosphere and ionosphere;

- Determine the physical and chemical processes that control loss processes;

- Determine escape rates of neutrals;

- Determine escape rates of ions;

- Determine the external inputs that control upper atmosphere and ionosphere structure and that drive escape; and

- Determine the relative escape rates of the stable isotopes and the resulting isotopic fractionation.

Additional information can be found at http://www.nasa.gov/maven.

Project Parameters

MAVEN will deliver its science using three instrument packages: a stand-alone neutral gas and ion mass spectrometer (NGIMS), capable of measuring thermal neutrals and ions; a stand-alone imaging ultraviolet spectrometer (IUVS); and the Particles and Fields package, consisting of six instruments measuring ionospheric properties, energetic ions, solar wind and solar energetic particles, magnetic fields, and solar extreme ultraviolet irradiance.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Development:	Mars Atmosphere & Volatile EvolutioN

Project Commitments

The MAVEN measurements will be made from an elliptical orbit with periapsis at 150 kilometers and apoapsis at 6220 kilometers (4.5-hour period). MAVEN will use a Sun-pointing, three-axis stabilized spacecraft, with a two-axis gimballed, Mars-pointing platform for the NGIMS, IUVS, and the SupraThermal And Thermal Ion Composition (STATIC) instruments. The spacecraft has a body-mounted high-gain antenna.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Launch Services	United Launch Services	Atlas V Launch Service	New	Same (reported as intermediate class launch service; Atlas V now selected)
Spacecraft	Lockheed Martin	MRO-heritage spacecraft bus and avionic suite, with cross strapping and monopropellant propulsion system	New	Same
Neutral Gas and Ion Mass Spectrometer (NGIMS)	GSFC	Mass Spectrometry Instrument	New	Same
Supra Thermal and Thermal Ion Composition (STATIC)	SSL	Part of the MAVEN particle and fields instrument package	New	Same
Solar Energetic Particles (SEP)	SSL	Part of the MAVEN particle and fields instrument package	New	Same
Solar Wind Electron Analyzer (SWEA)	SSL	Part of the MAVEN particle and fields instrument package	New	Same
Solar Wind Ion Analyzer (SWIA)	SSL	Part of the MAVEN particle and fields instrument package	New	Same
Lanamuir Probe and Waves and EUV (LPW/EUV)	LASP	Part of the MAVEN particle and fields instrument package	New	Same
Magnetometer	GSFC	Part of the MAVEN particle and fields instrument package	New	Same
Imaging Ultraviolet Spectrometer (IUVS)	LASP	Remote-Sensing Instrument package	New	Same
Electra	JPL	UHF Data Relay payload	New	Same

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Development:	Mars Atmosphere & Volatile EvolutioN

Schedule Commitments

NASA selected the second Mars Scout mission, MAVEN, for formulation on September 15, 2008. MAVEN was confirmed to proceed into implementation phase on October 4, 2010, with a November 2013 launch date and arrival at Mars in September 2014.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Formulation			
PDR	07/2010	New	Same
Development			
CDR	07/2011	New	Same
ATLO	07/2012	New	Same
Launch	11/2013	New	Same
Mars Orbit Insertion	09/2014	New	Same

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Development:	Mars Atmosphere & Volatile EvolutioN

Project Management

The MAVEN project is part of the Mars Exploration Program managed for NASA by the Mars Program Office at JPL. The PI for MAVEN is from the University of Colorado and has delegated the day-to-day management of the MAVEN Project to GSFC.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Project management, mission systems engineering, safety and mission assurance, and project scientist	GSFC	GSFC	
Neutral gas and ion mass spectrometer (NGIMS)	GSFC	GSFC	
Navigation, trajectory, and orbit maintenance analysis	GSFC	JPL	
Magnetometer (MAG) - Measures interplanetary, solar wind, and ionospheric magnetic fields	GSFC	GSFC	
Payloads	GSFC	GSFC	CNES
Spacecraft	GSFC		
Mission Operations	GSFC		
Launch Vehicle	KSC	KSC	
Ground Systems	GSFC		
Systems Integration and Testing	GSFC	GSFC	
E/PO	HQ	GSFC	
Science	HQ	GSFC	

Acquisition Strategy

All major acquisitions are in place. MAVEN was selected competitively on September 15, 2008, under the Mars Scout 2006 Announcement of Opportunity (AO-NNH06ZDA002O).

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SRB	07/2010	The MAVEN Project passed the Preliminary Design Review (PDR)/Non-Advocacy Review (NAR) conducted by the independent Standing Review Board in July 2010.	07/2011

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Development:	Mars Atmosphere & Volatile EvolutioN

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Single Point Failures on High Efficiency Power Supply (HEPS) Card	If single point failures on the input of the HEPS card occur, then permanent loss of spacecraft electrical power will result.	The project and Goddard Mission Assurance Office are identifying and understanding HEPS-specific manufacturing techniques; identifying all single point failures to inspect during assembly to mitigate against shorts; developing a plan for insight/oversight of the MAVEN-specific HEPS card build; and reviewing board requirements with an eye towards design robustness and remaining design requirements.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Outer Planets

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**100.6**	**-**	**120.8**	**80.5**	**82.2**	**84.1**	**88.5**
Outer Planets	100.6	-	120.8	80.5	82.2	84.1	88.5

Note:
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Program Overview

The Outer Planets Program consists of three strategic elements: the ongoing Cassini mission to Saturn; Supporting Research and Technology (SR&T); and a pre-formulation study effort for a future outer planets mission. These elements enable science investigations across a broader array of disciplines and in more depth than smaller, tightly focused competed missions. The science discoveries made by these strategic missions are not expected to be easily displaced with time and are expected to overthrow previous paradigms and create new ones in their place.

Plans For FY 2012

The Senior Review Board recommended the Cassini Solstice mission, the project's third mission extension, to observe seasonal and temporal change in the Saturn system through March 2018.

The recommendations of the next Planetary Science decadal survey, expected in March 2011, will determine the science priority for the next outer planets mission.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Outer Planets

Project Descriptions and Explanation of Changes

Outer Planets

Cassini-Huygens, in its extended operations phase, is an Outer Planets flagship mission to Saturn that has profoundly altered our understanding of that planet, its famous rings, magnetosphere, icy satellites, and particularly the moons, Titan and Enceladus. Cassini-Huygens is an international collaborative effort. It was launched in October 1997 and arrived at Saturn in July 2004 in order to explore the Saturn system in detail, including its rings and moons. A major focus is Saturn's largest moon, Titan, with its dense atmosphere, methane-based meteorology, and geologically active surface. Cassini completed its prime mission in July 2008, completed its Equinox mission in July 2010, and began the Solstice mission in October 2010. The Solstice mission will observe seasonal and temporal change in the Saturn system, especially at Titan, to understand underlying processes, and prepare for future missions. The Cassini Solstice mission will continue to operate and conduct data analysis through March 2018.

The SR&T effort dramatically increases the scientific return of NASA missions and guides current mission operations (e.g., selecting Cassini imaging targets), as well as future mission planning (e.g., mission concept studies for Titan missions). The competitive programs within the SR&T effort increase understanding of the outer solar system and broaden the science community participation in the analysis of data returned by Cassini, Galileo, and other missions.

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Deliver science data to Planetary Data Systems (PDS) consistent with science archive plan (in increments within 6 - 9 months)	Cassini	same
Release ROSES and make selections	Research Data Analysis	same

Implementation Schedule

Project	Schedule by Fiscal Year															Phase Dates		
	Prior	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24		Beg	End
Cassini																	Tech		
																	Form		Sep-89
																	Dev	Oct-89	Oct-97
																	Ops	Oct-97	Sep-17
																	Res	Oct-97	Sep-17
Research Data Analysis																	Tech		
																	Form		
																	Dev		
																	Ops		
																	Res	Oct-97	Sep-24

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Outer Planets

Program Management

Management responsibility for the Cassini and pre-formulation of the Outer Planets future mission concept development resides at JPL. Scientific mission priorities for the program and the research efforts reside within SMD/Planetary Science Division.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Cassini	JPL	JPL	The Italian Space Agency provided Cassini's high-gain communication antenna and the Huygens probe was built by the European Space Agency (ESA).
Outer Planets Pre-project Formulation	JPL	JPL	ESA
Research Data Analysis	HQ	Multi-Center	None

Acquisition Strategy

All major acquisitions contracts for Cassini are in place. The acquisition strategy for future Outer Planets missions will be determined in Spring 2011 after receipt of the results of the Planetary decadal survey. The science payloads will be competitively selected for the Outer Planets future mission.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	Senior Review Panel	02/2009	Cassini senior review for the Solstice extended mission recommended approval of the extended mission science.	02/2012

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Technology

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**105.5**	**-**	**122.9**	**104.1**	**86.6**	**84.9**	**85.4**
Technology	105.5	-	122.9	104.1	86.6	84.9	85.4

Note:
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Program Overview

Planetary Science missions demand advances in both power and propulsion systems to enable successful trips to harsh environments, far from the Sun, with highly challenging trajectories and operations. To meet these needs, the Planetary Science Technology program includes the In-Space Propulsion (ISP), Radioisotope Power Systems (RPS), and Advanced Multi-Mission Operations System (AMMOS) projects.

The ISP project develops in-space propulsion technologies that can enable or benefit near- and mid-term NASA missions. These technologies will enhance the performance of planetary science missions by allowing increased science payload mass, reduced launch costs, and decreased mission trip times. The RPS project advances the capabilities of spacecraft power systems, thereby making it possible for missions to travel to destinations distant from the sun, or where sunlight is obscured or infrequent. RPS is developing flight Advanced Stirling Radioisotope Generators (ASRG) for the 2014 time frame. AMMOS provides planetary science missions with a set of operations, navigation and design software tools and services for flight mission training, mission operations, space communications resources allocation, and improved space communication. NASA's portion of the budget for restarting the Nation's plutonium production capacity, shared with DOE, is also included in the program.

In close cooperation with the Office of the Chief Technologist, these technology investments focus on the unique needs of robotic planetary missions, and leverage Agency cross-cutting efforts in space propulsion, power, and automation/operations technologies.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Technology

Plans For FY 2012

ISP completed the electric propulsion Hall thruster development task in FY 2011 and starts long duration testing in FY 2012. The Hall system power processing unit continues development in FY 2012. The ISP project will complete electric propulsion life validation testing of NASA's Evolutionary Xenon Thruster (NEXT) in FY 2012. In FY 2012, the ISP project will continue propulsion system component development for a Mars Ascent Vehicle (MAV) capability and will continue lightweight propellant tank development for the Skycrane. In FY 2012, the ISP project will complete the preliminary design of an Earth entry vehicle (EEV) concept and establish EEV heat shield micro-meteoroid/orbital debris characteristics.

In FY 2012, RPS will continue an extended performance testing of the Advanced Stirling Radioisotope Generator (ASRG) engineering unit, and continue the development of a qualification unit to enable delivery of one ASRG flight unit for the 2016-2017 Discovery flight opportunity. RPS will continue the development of advanced radioisotope thermoelectric generator couples by validating lifetime and four couple module power. RPS will also fund DOE safety testing to verify safety models for solid upper stages.

AMMOS will continue to provide multi-mission operations software tools for spacecraft navigation and mission planning, efficient spacecraft communication, and data handling.

In addition, this Planetary Science Technology Program will pursue complimentary collaborations with the new crosscutting Space Technology program within the Office of the Chief Technologist.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Technology

Project Descriptions and Explanation of Changes

Technology

ISP will enable access to more challenging and interesting science destinations, including enabling sample return missions. ISP continues to advance several propulsion technologies in support of future Flagship, Discovery, Mars, and New Frontiers missions. The ISP portfolio continues to invest in high-priority technology areas such as the electric propulsion and aerocapture/Earth entry, descent, and landing technologies identified in the Solar System Exploration Roadmap and the 2010 SMD Science Plan. ISP will continue increasing its emphasis on sample return propulsion technology development. The foci will be: continuing propulsion component technology development for a MAV and preparing for MAV flight system development; completing EEV heat shield micro-meteoroid/orbital debris characteristics studies, a preliminary design of a multi-mission Earth entry vehicle (MMEEV) concept and continuing MMEEV technology development; and initiating thruster long duration testing and continuing other subsystem technology developments for the High Voltage Hall Accelerator (HiVHAC) thruster technology applicable to Earth return vehicles (ERV), transfer stages, and low-cost electric propulsion systems for Discovery-class missions. The ISP project will be responsive to the Planetary 2011 decadal survey.

RPS continues low-level investments in advanced Stirling, thermoelectric conversion, and thermal photovoltaic technologies in response to mission needs identified by the Planetary decadal survey. The RPS project also funds cross-cutting multi-mission activities to keep them off the critical path for future RPS mission, such as NEPA process development, multi-mission launch vehicle data book development, safety analysis and testing, and radiological contingency response process improvement. This work is critical to facilitate the application of RPS. RPS is structured to manage both the technology investments and systems development, such as the development and testing of the ASRG. The project transitions acquisition of flight units to a mission-specific user. The project also assumes responsibility for multi-mission RPS studies, sustaining capabilities, and crosscutting launch approval activities. However, funds are not included within the RPS budget for the procurement of nuclear material required to support missions in formulation, or the development of DOE capabilities to produce Plutonium-238.

AMMOS provides multi-mission operations, navigation, design, and training tools for Planetary Science flight missions, and undertakes technology investments for improved communications and navigation technologies.

NASA and DOE have initiated project pre-planning and activities for implementing a Pu-238 production restart. NASA continues to assess the need and schedule for plutonium. Mission studies, conducted by the NASA Radioisotope Power System (RPS) program based on the Planetary decadal survey mission set have revalidated the need for additional Pu-238 supplies.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Technology

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
HiVHAC Engineering Model (EM) thruster long duration test will be initiated	ISP	New
NEXT long duration test will be completed with a goal of achieving 750Kg of Xenon throughput	ISP	New
Earth Entry Vehicle (EEV) preliminary design complete	ISP	New
Mars Ascent Vehicle (MAV) propulsion system technology development preliminary design complete	ISP	New
Advanced Stirling Radioisotope Generator engineering model will demonstrate extended operations (14,000 hours)	RPS	same
Provide standard interfaces in order to enable interoperability among missions	AMMOS	same

Program Management

SMD provides overall oversight of the Technology program. GRC is responsible for the ISP and RPS projects. JPL is responsible for the AMMOS project.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
ISP	GRC	GRC, MSFC, JPL, LARC, ARC	None
RPS	GRC	JPL, GRC, KSC	Department of Energy
AMMOS	JPL	JPL	None
Plutonium Restart	HQ	GRC	DOE

Acquisition Strategy

Technology activities are solicited using NASA ROSES announcement, and selections are made using a competitive, peer-reviewed process. The Department of Energy completed an acquisition for ASRG flight system development (Lockheed Martin) for RPS. JPL provides management and the navigation and space communication software tools.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Technology

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	National Academies	12/2010	Assessing the restart and sustainment of domestic production of radioisotope heat source material for deep space and other exploration missions. Assessing the development of and standards for flight certification of ASRG for flagship and other missions.	TBD
Performance	SRB/IPAO	09/2010	Program Implementation Review. Based on the program readiness and SRB recommendation, subsequent Agency approval was granted to the RPS program on December 9, 2010, by the Agency Program Management Council (APMC).	09/2012